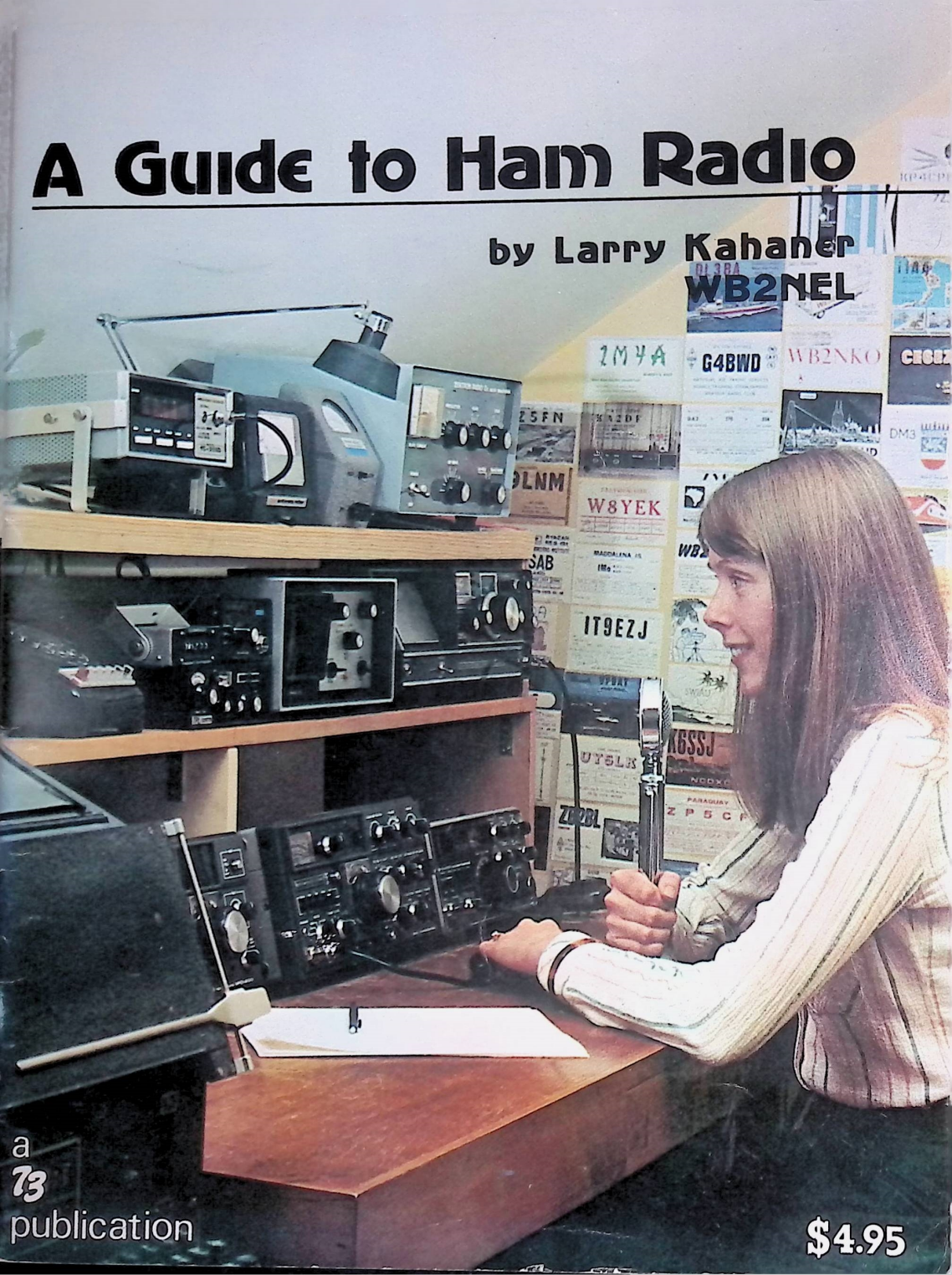
A Guide to Ham Radio

by Larry Kahaner
WB2NEL



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CONTENTS

PROLOGUE

HOW FAR CAN YOU GET?

When I tell someone that I am a ham, the first question is, "How far can you get?"

My answer, honed over the years, is: "I guess Australia. After that we are coming back."

It's a wise aleck answer but it helps to make the point: Hams can reach anywhere in the world.

After that is settled, I mention that the equipment needed to "work the world" can be simple and cheap or exotic and expensive — your choice. I add that while a monster antenna system works best, a small indoor job also does the trick.

Next question is usually, "Is that Citizen's Band?"

"No," and I add that the two services are completely separate and have nothing to do with each other. Ham radio operators must take a theory test and code test, while CBers get licenses upon application. And I explain that CBers aren't permitted to transmit over 150 miles. CB doesn't allow experimentation and doesn't allow any other mode beside voice. I go on to say that there are more differences too, but we won't go into them now.

If all procedes as usual, the next statement I hear is, "Oh, I could never pass the test, especially the code." My reply is always the same.

"Are you kidding. Anyone who puts his mind to it can do it. Most hams are *not* in the electronic field. They are in every situation, job and age category imaginable. There are so many books, tapes and stuff to help you get a license that anyone, who is serious about becoming a ham, can pass."

Dazzled by my footwork, my pupil begins to think about being a ham. I can tell by the far away look.

Chapter I
Introduction

Why Can't I Just Get On and Talk

Ham radio, or amateur radio, is the world's most exciting hobby. It lets you communicate with people all over the globe. You can use voice, Morse code, teletype, television, even a satellite in orbit.

Over 700,000 hams are found in every social, economic, political category you can think of. When you get on the air and call "CQ", a general call to anyone, you may contact a ham on an Arctic ship or one sitting comfortably in his home in Australia. This is ham radio's thrill; from your own station you can talk with someone who shares your love of communication.

In the United States, anyone can get an amateur license. There are no restrictions, not age, sex, or education. Disabled, blind, even deaf hams have overcome their handicaps to "travel" around the world.

Each country has its own radio regulatory agency. The Federal Communications Commission (FCC) keeps order in the United States and decides which services are necessary and allots frequencies for them to use. Working closely with the International Telecommunications Union (ITU), a part of the United Nations, the FCC sees that stations do not interfere with each other and that frequencies for international use such as maritime, airline and space vehicles are available.

International cooperation, as well as national coordination, is necessary for communications to exist in an orderly manner. What a mess we would be in if the fire department's messages were interfered with by someone using a remote control garage opener. What chaos if each station decided to transmit wherever it pleased.

Frequencies are assigned in blocks according to service. One is the public safety service. This group includes fire departments, police departments, Civil Defense and other agencies engaged in public protection. They are given special frequencies which no one else can use.

The broadcasting service, composed of television and radio stations is another necessary group. They serve the public interest with entertainment and information.

Other services are: aircraft, maritime, space, industrial, citizens band, military and amateur. There are many more.

To get a frequency, you must prove that you really need one. Recently, the spectrum is getting crowded by the great number of transmitters used, and people are realizing that careful management is needed. The radio spectrum can be thought of as a natural resource like air or water — prone to pollution. Its precious frequencies should not be allotted without just cause.

Radio and television stations are "public trustees" and use *our* frequencies. When license renewal time comes, every few years, the public is asked to comment on the quality of work the station is doing. Stations *have* actually *lost* licenses because the FCC agreed with the people that the station did not serve the community interest and should not use the airwaves.

It behooves all radio services, amateur included, to show they use the spectrum for the public good. The record for ham radio is impressive.

Hams use their communications skills in public service so often it rarely makes the news anymore. One event that did make the headlines, however, was the emergency operation during the Guatemalan earth-

Tom Christian, descendant of the H.M.S. Bounty's Christian, lives on Pitcairn Island and operates amateur radio station VR6TC.

quake of February 1976.

Within two hours after the first shock, (7.5 on the Richter scale) amateurs were receiving and transmitting messages from that devastated country. The first news of the disaster was from a ham who broke into a conversation between two American hams. Amateurs quickly formed the Guatemalan Emergency Network to move supplies and pass messages. Guatemalan hams, using emergency power, manned radios around the clock. In fact, within four hours after the earthquake, Miami Red Cross reported at least three separate networks engaged in emergency operation.

In New York City, the Hall of Science Radio Club, operating a permanent station from the old World's Fair site, provided assistance from the New York area. It handled between 75 and 100 messages from concerned relatives and friends asking about those in the quake zone.

The Palisades Amateur Radio Club in California received over 3000 names to process for information. For many days, ham radio was the only link to Guatemala. Even Guatemala officials in Washington used ham radio to contact their country!

Think . . . all this done by hams, on a voluntary basis, without pay and without government aid. All on their own.

The list of emergency communications actions by hams can go on and on. But let's get to the other reasons for ham radio.

Experimentation is an amateur radio purpose. Freedom to tinker makes hams prolific in finding new modes and techniques.

Hams were the first users of a method known as single sideband. Now, all communications which are not FM and AM broadcast stations are single sideband. It is used exclusively by the military and maritime service.

A ham encouraged the Connecticut police to use FM instead of noisy and static-ridden AM. It took a while to convince them, but now all police departments use FM.

Slow scan television was developed by hams. You may remember the early moon pictures. It took a few seconds for the full picture to form on the screen. That is slow scan TV. Hams use it all the time, sending

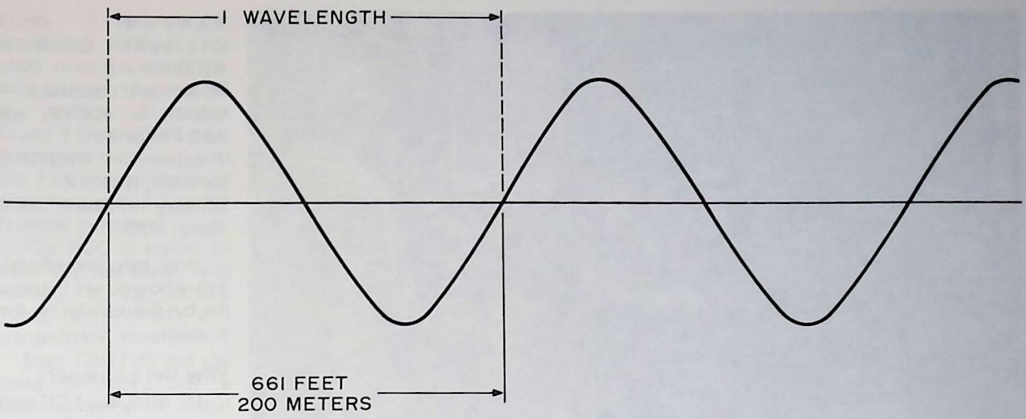


Fig. 1-1. A radio wave which has a frequency of 660 kHz has a wavelength of 200 meters long.

pictures to each other around the world.

Ham radio permits individual growth in radio and electronic skills. Many of the World War II signal corpsmen were hams and needed little training when war broke; they already knew Morse code and radio techniques. A great number of engineers and scientists had roots in ham radio because it allowed them an opportunity to advance themselves in the radio arts.

Another principle of amateur radio is continuation and extension of the amateur's ability to enhance international good will. Politics rarely stand in the way of ham radio contacts.

Where Are the Hams?

All energy transmissions are composed of waves and these waves have specific frequencies. Light waves, for instance, are very high in frequency, about 10^{15} cycles per second. That's 1 with 15 zeroes after it. A cycle per second is called a *Hertz* and is abbreviated *Hz*. Thus 10^{15} cycles per second is 10^{15} Hz. Audible sound is very low in frequency, on the order of 1000 Hz. Much of the space between these extremes is used for radio transmissions.

A frequency can be referred to by its *wavelength*. The higher the frequency, the shorter the wavelength; and the lower the frequency, the longer the wavelength. For example, WNBC-AM in New York City operates on 660 kilohertz (660kHz) — 660,000 Hz. The wavelength of one cycle at that frequency is about 661 feet long or 200 meters (Fig. 1-1).

Ham radio frequencies are commonly known by wavelength instead of frequency. Thus, a ham operating on 14.2 megahertz (14.2 million Hertz) says he is 'operating 20' — transmitting on a frequency with a wavelength of 20 meters.

A group of frequencies is called a *band*. For convenience, radio frequencies are divided into bands ranging from Very Low to Ultra High (Fig. 1-2). But the terms are relative and change constantly. What we thought were 'short waves' many years ago are no longer considered short. We can now transmit on frequencies so high that they approach the frequencies of light.

The longer the wavelength, the less likely the

160 m band — good for daylight communications up to 25 miles. On winter nights, several thousand miles range is possible.

80 m band — about 200 miles in daylight operation. Long distances of a few thousand miles are common at night. Atmospheric noise is high during the summer.

40 m band — similar to the 80 m band but greater distances are possible during the day. In winter dawn and dusk periods the whole world can be worked in this band.

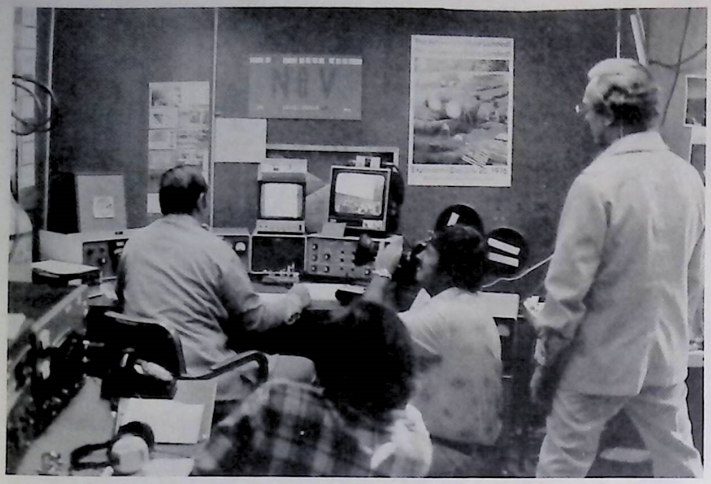
20 m band — this is the best band for daylight operation. When solar sunspots are numerous the entire world is accessible during the day and night.

15 m band — this band depends upon the solar sunspots for long distance work. When sunspots are low, it is still useful for daylight work of a few thousand miles.

10 meters — during the peak solar sunspot cycle this band is excellent for spanning great distances mostly during the daytime.

above 6 meters — long distance operation depends upon atmospheric conditions which vary with sunspot activity, weather and other atmospheric conditions. Line of sight communication is extremely reliable and depends upon antenna height and power. 50-100 miles is the usual range.

Table 1-1. Propagation characteristics for some ham bands.



Special event station N6V sending Slow Scan pictures of Mars to hams from Viking I & II.

radio energy will escape through the atmosphere into space. More often than not, it will bounce off the atmosphere and come back to earth (Fig. 1-3). This makes world-wide communication possible. The high frequency, small wavelength signals are usually confined to line-of-sight communications.

Hams use their knowledge of waves and frequencies to choose the proper band according to conditions and purposes (Fig. 1-4). Table 1-1 shows the ham bands and their use. Note that wave propagation, the study of how waves bounce, depends upon time of day, frequency of your signal, and season.

How Are Stations Named?

All transmitting stations have call letters. Through international agreements, each country has a group of letters or numbers and letters for prefixes (Table 1-2). Then a scheme is devised for all the different stations in that country.

The United States has the following prefix blocks to use: W, K, A, and N. *All* U.S. stations begin with one of these letters, then each service forms its own scheme. There are slight exceptions, but here is the plan:

Public Service — KXX-###
Citizens Band — KXX-####
Radio and television — WXXX or KXXX; add AM, FM or TV.
Amateur — WX#XXX, K#XXX, N#XXX
Military — Army: AXX, Navy: NXX

You can immediately tell who you are listening to by the call letter formation.

Why Get a License?

In 1958, the FCC took a portion of the 11 meter ham band and turned it into a newly formed service known as Citizens Band. The public would be served by allowing it access to the airwaves for business and personal use. There was no test and all users were to abide by the rules. Licenses were issued upon application. Operators were not permitted to transmit over 150 miles and were not allowed to tinker or adjust their own equipment which was approved by the FCC. At first it worked well but was swarmed by those who did not realize the great power of the spec-

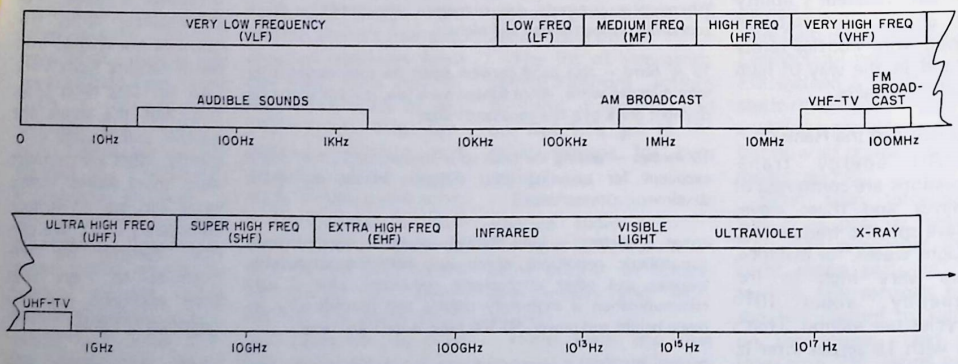


Fig. 1-2. The electromagnetic spectrum. AM and FM broadcasting bands are shown.

trum. It became increasingly difficult for good users to communicate properly because of the spoilers. Businesses found it impossible to get messages through, and the FCC had to open up new frequencies just for business purposes.

The FCC is trying to keep the bad users from ruining it for others. Fines are levied and transmitters confiscated.

Most CBers *do* use the band properly, but a large minority of illegal operators still exists. The fault is that more CBers are not trained to appreciate the spectrum as an important and powerful resource. CB is the public's first association with radio. In general, the problem is universal. Other countries have CB and the results are similar. Belgium has closed all of its CB stations because of misuse.

Walkie-Talkies with access to telephone lines help police.

Since the increased popularity of CB in this country, many CBers realize that what they really want is not CB, but ham licenses. They want the leeway that amateur radio gives. It allows more power, different modes and many choices in equipment. And ham radio permits worldwide communication legally.

So, quite by accident, many good CBers learn of ham radio and study for licenses. Nothing in the rules prevents a person from holding both licenses simultaneously. Studying radio theory gives you a greater respect for the airwaves. Learning electronic theory enables the operator to fix and adjust his own equipment. No other service permits this. Also, studying the rules makes you aware of the need for regulations if communication is to exist without chaos.

Let's not forget that when you work for something it is always worth more to you than if you get it free. And the ham radio license is worth working for.

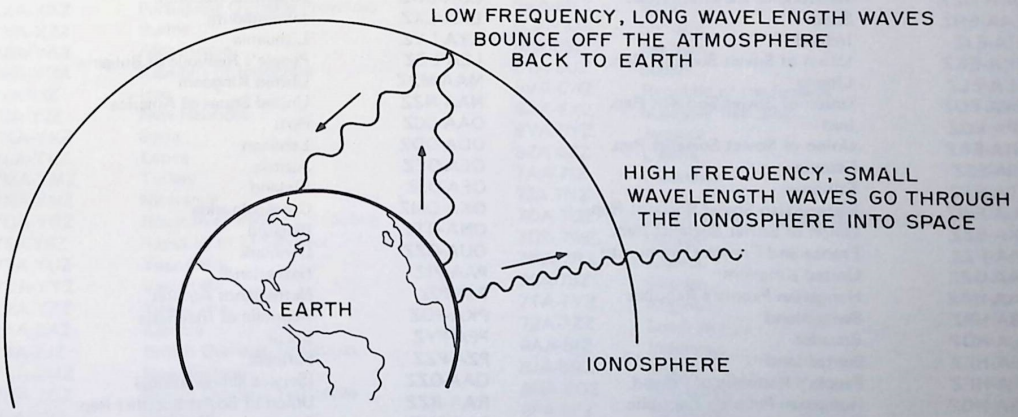


Fig. 1-3. Worldwide communications relies on low frequency radio waves bouncing off the atmosphere — sometimes called "skip."

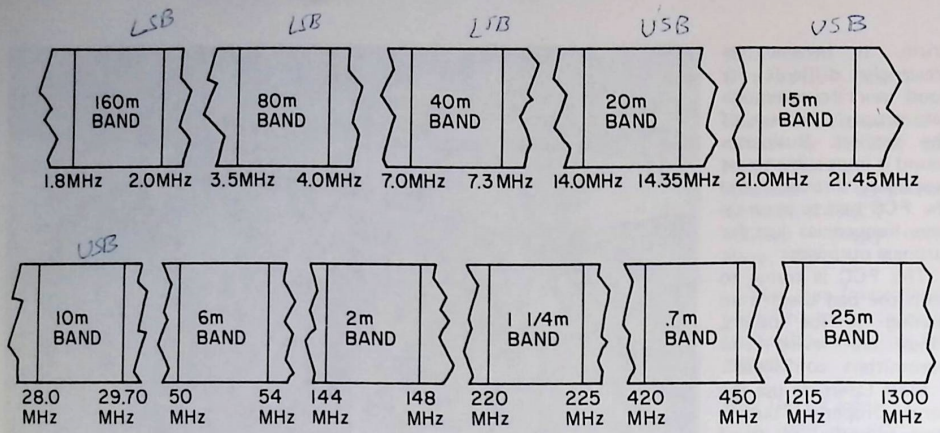


Fig. 1-4. The most popular ham bands — there are more above .25 meters.

Table 1-2. Country prefix list.

AAA-ALZ	United States of America
AMA-AOZ	Spain
APA-ASZ	Pakistan
ATA-AWZ	India
AXA-AXZ	Commonwealth of Australia
AYA-AZZ	Argentine Republic
BAA-BZZ	China
CAA-CEZ	Chile
CFA-CKZ	Canada
CLA-CMZ	Cuba
CNA-CNZ	Morocco
COA-COZ	Cuba
CPA-CPZ	Bolivia
CQA-CRZ	Portuguese Overseas Provinces
CSA-CUZ	Portugal
CVA-CXZ	Uruguay
CYA-CZZ	Canada
DAA-DTZ	Germany
DUA-DZZ	Republic of the Phillippines
EAA-EHZ	Spain
EIA-EJZ	Ireland
EKA-EKZ	Union of Soviet Socialist Rep.
ELA-ELZ	Liberia
EMA-EOZ	Union of Soviet Socialist Rep.
EPA-EQZ	Iran
ERA-ERZ	Union of Soviet Socialist Rep.
ESA-ESZ	Estonia
ETA-ETZ	Ethiopia
EUA-EWZ	Bielorussian Soviet Socialist Rep.
EXA-EZZ	Union of Soviet Socialist Rep.
FAA-FZZ	France and French Community
GAA-GZZ	United Kingdom
HAA-HAZ	Hungarian People's Republic
HBA-HBZ	Switzerland
HCA-HDZ	Ecuador
HEA-HEZ	Switzerland
HFA-HFZ	People's Republic of Poland
HGA-HGZ	Hungarian People's Republic
HHA-HHZ	Republic of Haiti
HIA-HIZ	Dominican Republic
HIA-HKZ	Republic of Colombia
HLA-HMZ	Korea
HNA-HNZ	Iraq
HOA-HPZ	Republic of Panama
HQA-HRZ	Republic of Honduras
HSA-HSZ	Thailand
HTA-HTZ	Nicaragua
HUZ-HUZ	Republic of El Salvador
HVA-HVZ	Vatican City State
HWA-HYZ	France and French Community
HZA-HZZ	Saudi Arabia
IAA-IZZ	Italy
JAA-JSZ	Japan
JTA-JVZ	Mongolian People's Republic
JWA-JXZ	Norway
JYA-JYZ	Jordan
JZA-JZZ	Western New Guinea
KAA-KZZ	United States of America
LAA-LNZ	Norway
LOA-LWZ	Argentine Republic
LXA-LXZ	Luxembourg
LYA-LYZ	Lithuania
LZA-LZZ	People's Republic of Bulgaria
MAA-MZZ	United Kingdom
NAA-NZZ	United States of America
OAA-CCZ	Peru
ODA-ODZ	Lebanon
OEA-OEZ	Austria
OFA-OJZ	Finland
OKA-OMZ	Czechoslovakia
ONA-OTZ	Belgium
OUA-OZZ	Denmark
PAA-PIZ	Netherlands
PJA-PJZ	Netherlands Antilles
PKA-POZ	Republic of Indonesia
PPA-PYZ	Brazil
PZA-PZZ	Surinam
QAA-QZZ	(Service abbreviations)
RAA-RZZ	Union of Soviet Socialist Rep.
SAA-SMZ	Sweden
SNA-SRZ	People's Republic of Poland
SSA-SSM	United Arab Republic

SSN-STZ	Sudan
SUA-SUZ	United Arab Republic
SVA-SZZ	Greece
TAA-TCZ	Turkey
TDA-TDZ	Guatemala
TEA-TEZ	Costa Rica
TFA-TFZ	Iceland
TGA-TGZ	Guatemala
THA-THZ	France and French Community
TIA-TIZ	Costa Rica
TJA-TJZ	Republic of Cameroon
TKA-TKZ	France and French Community
TLA-TLZ	Central African Republic
TMA-TMZ	France and French Community
TNA-TNZ	Republic of Congo (Brazzaville)
TOA-TQZ	France, French Community
TRA-TRZ	Republic of Gabon
TSA-TSZ	Tunisia
TTA-TTZ	Republic of Chad
TUA-TUZ	Republic of the Ivory Coast
TVA-TXZ	France and French Community
TYA-TYZ	Republic of Dahomey
TZA-TZZ	Republic of Mali
UAA-UOZ	Union of Soviet Socialist Republics
URA-UTZ	Ukrainian Soviet Socialist Rep.
UUA-UZZ	Union of Soviet Socialist Republics
VAA-VGZ	Canada
VHA-VNZ	Commonwealth of Australia
VOA-VOZ	Canada
VPA-VSZ	British Overseas Territories
VTA-VWZ	India
VXA-VYZ	Canada
VZA-VZZ	Commonwealth of Australia
WAA-WZZ	United States of America
XAA-XIZ	Mexico
XJA-XOZ	Canada
XPA-XPZ	Denmark
XQA-XRZ	Chile
XSA-XSZ	China
XTA-XTZ	Republic of the Upper Volta
XUA-XUZ	Cambodia
XVA-XVZ	Viet Nam
XWA-XWZ	Laos
XXA-XXZ	Portuguese Overseas Provinces
XYA-XZZ	Burma
YAA-YAZ	Afghanistan
YBA-YHA	Republic of Indonesia
YIA-YIZ	Iraq
YJA-YJZ	New Hebrides
YKA-YKZ	Syria
YLA-YLZ	Latvia
YMA-YMZ	Turkey
YNA-YNZ	Nicaragua
YOA-YRZ	Roumanian People's Republic
YSA-YSZ	Republic of El Salvador
YTA-YUZ	Yugoslavia
YVA-YYZ	Venezuela
YZA-YZZ	Yugoslavia
ZAA-ZAZ	Albania
ZBA-ZJZ	British Overseas Territories
ZKA-ZMZ	New Zealand
ZNA-ZOZ	British Overseas Territories
ZPA-ZPZ	Paraguay
ZQA-ZQZ	British Overseas Territories
ZRA-ZUZ	Republic of South Africa
ZVA-ZZZ	Brazil
2AA-2ZZ	Great Britain
3AA-3AZ	Monaco
3BA-3BZ	Mauritius
3CA-3CZ	Equatorial Guinea
3DA-3FZ	Canada
3GA-3GZ	Chile
3HA-3UZ	China
3VA-3VZ	Tunisia
3WA-3WZ	Viet Nam
3XA-3XZ	Guinea
3YA-3YZ	Norway
3ZA-3ZZ	People's Republic of Poland
4AA-4CZ	Mexico
4DA-4IZ	Republic of the Philippines
4JA-4LZ	Union of Soviet Socialist Rep.
4MA-4MZ	Venezuela
4NA-4OZ	Yugoslavia
4PA-4SZ	Sri Lanka
4TA-4TZ	Peru
4UA-4UZ	United Nations
4VA-4VZ	Republic of Haiti
4WA-4WZ	Yemen
4XA-4XZ	State of Israel
4YA-4YZ	International Civil Aviation Org.
4ZA-4ZZ	State of Israel
5AA-5AZ	Libya
5BA-5BZ	Republic of Cyprus
5CA-5GZ	Morocco
5HA-5IZ	Tanzania
5 A-5KZ	Colombia
5LA-5MZ	Liberia
5NA-5OZ	Nigeria
5PA-5QZ	Denmark
5RA-5SZ	Malagasy Republic
5TA-5TZ	Islamic Republic of Maurentania
5UA-5UZ	Republic of the Niger
5VA-5VZ	Togolese Republic
5WA-5WZ	Western Samoa
5XA-5XZ	Uganda
5YA-5ZZ	Kenya
6AA-6BZ	United Arab Republic
6CA-6CZ	Syria
6DA-6JZ	Mexico
6KA-6NZ	Korea
6OA-6OZ	Somalia
6PA-6SZ	Pakistan
6TA-6UZ	Sudan
6VA-6WZ	Republic of the Senegal
6XA-6XZ	Malagasy Republic
6YA-6YZ	Jamaica
6ZA-6ZZ	Liberia
7AA-7IZ	Indonesia
7JA-7NZ	Japan
7OA-7OZ	South Yemen Popular Republic
7QA-7QZ	Malawi
7RA-7RZ	Algeria
7SA-7SZ	Sweden
7TA-7YZ	Algeria
7ZA-7ZZ	Saudi Arabia
8AA-8IZ	Indonesia
8JA-8NZ	Japan
8OA-8OZ	Botswana
8PA-8PZ	Barbados
8QA-8QZ	Malaive Islands
8RA-8RZ	Guyana
8SA-8SZ	Sweden

8TA-8YZ	India
8ZA-8ZZ	Saudi Arabia
9AA-9AZ	San Marino
9BA-9DZ	Iran
9EA-9FZ	Ethiopia
9GA-9GZ	Ghana
9HA-9HZ	Malta
9IA-9JZ	Zambia
9KA-9KZ	Kuwait
9LA-9LZ	Sierra Leone
9MA-9MZ	Malaysia
9NA-9NZ	Nepal
9OA-9TZ	Republic of the Congo (Leopoldville)
9UA-9UZ	Burundi
9VA-9VZ	Singapore
9WA-9WZ	Malaysia
9XA-9XZ	Rwanda
9YA-9ZZ	Trinidad and Tobago
A2A-A2Z	Republic of Botswana
C2A-C2Z	Republic of Nauru
C3A-C3Z	Principality of Andorra
L2A-L9Z	Argentina

Chapter II

More Than Just Talk

Morse Code

Morse code is the simplest form of radio communication. We turn our transmitter on and off corresponding to dots and dashes.

Still the most efficient mode available, Morse code or CW (short for continuous wave) is ideal for low power transmitters and perfect for high noise and static situations. After all, we only need to hear dits and dahs and not full words and phrases. Code transmissions "cut through" when others can't. Because code transmissions take up little bandwidth, more code conversations can take place within a given band.

Code transmitters and receivers are simple and cheap. They can also be made small for easy field operation.

Perhaps the greatest advantage of code comes when talking to hams who do not speak English. A universal "Q signal" language exists among hams which cuts across language barriers (Table 2-1). These Q signals consist of three letter groups beginning with the letter "Q." Each has a complete thought and meaning. For instance, an operator sends. "QTH?" This means "what is your location?" And an appropriate reply: "QTH Moscva" (Moscow). Without the question mark, it means "my location is . . ." Any ham knows about 15 or 20 Q signals. Everyone uses them and you can't help but pick them up quickly.

Many shorthand abbreviations make ham communications easier (Table 2-2). Abbreviations such as, PSE — please, TNX — thanks, CUA — see you again, WX — weather, SKED — schedule, FB — fine business (good show!) and 73 — best regards, are known to all hams, even those whose language does not use English letters. (Incidentally, if you are wondering about 73 meaning best regards — it's an old railroad telegrapher's term. In the Wild West the finest thing you could do was will your trusty Winchester 73 to your friend. That was a real pal. After a while it came to mean "my best" to you; then, "best regards.")

But don't think that Morse code dwells in the old West as far as equipment is concerned. The use of semi-automatic keys makes code sending easy, fast and fun.

The conventional straight key moves vertically. You hold it down to make dots and dashes. The semi-automatic key, called a paddle, swings from side to side between your thumb and forefinger. To the right, dots; to the left, dashes. In conjunction with a keyer, that you can build or buy, Morse code characters form with perfect spacing.

The dots and dashes are fed into the transmitter as if you used a simple straight key. The advantages of paddles and keyers are many. First, it is much less tiring to swing a paddle from side to side rather than up-down as when using a conventional key. You can operate for many hours without fatigue. Secondly, using a straight key requires you to form each dot and dash. Your timing must be quite good. The keyer takes care of the timing by assuring that each dot and dash is exactly the correct length. In addition, keyers do not allow you to make the elements (dots and dashes) too close to each other. In other words, keyers not only time each dot and dash length but also the interval between them.

Keyers have speed controls that you set for desired rate. You cannot send faster than this rate, and you can only send slower in the sense that you can leave long pauses between words and let-

ters.

Some hams send code with keyboards. By typing out letters, which are converted electronically to dots and dashes, high speed conversations take place. Copying speeds over 20 words per minute, in your head, is not unusual at all.

Voice

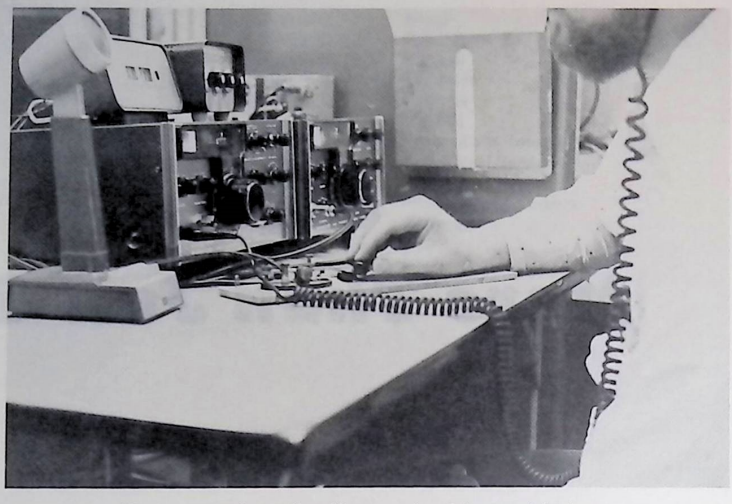
When propagation conditions are good, voice communication accounts for most ham contacts. The voice field has many entries, including AM (amplitude modulation) like your 550 to 1600 kHz broadcast radio, FM (frequency modulation) like your 88 to 108 MHz FM band and single sideband (SSB). All low band (80-10 meters) transmissions are single sideband with only a smattering of AM around. SSB not only takes less bandwidth than conventional AM, allowing more room for everyone, but also sends more power to the antenna.

If you transmit on a frequency of 4 MHz using amplitude modulation (AM), not only is the 4 MHz signal transmitted but so are two sidebands which carry your voice patterns (Fig. 2-1a). Speaking at a frequency of 1000 Hz (nobody actually speaks at only one frequency; we speak at many. But what happens at 1000 Hz in this example, happens instantaneously for every frequency we utter) will form two sidebands each 1000 Hz from the 4MHz carrier signal. As you can see, AM uses lots of bandwidth — in this example 2000Hz total.

Since each sideband carries the same information we can suppress one, either upper or lower, and transmit the other one. We can also suppress the carrier signal; it carries no information (Fig. 2-1b).

What we have left is a narrower bandwidth signal. We also have a more potent signal because power is not wasted transmitting an extraneous sideband and a useless carrier signal.

FM, on the other hand, takes up much more space than SSB. The advantage of FM is voice quality. You can tell the difference between music



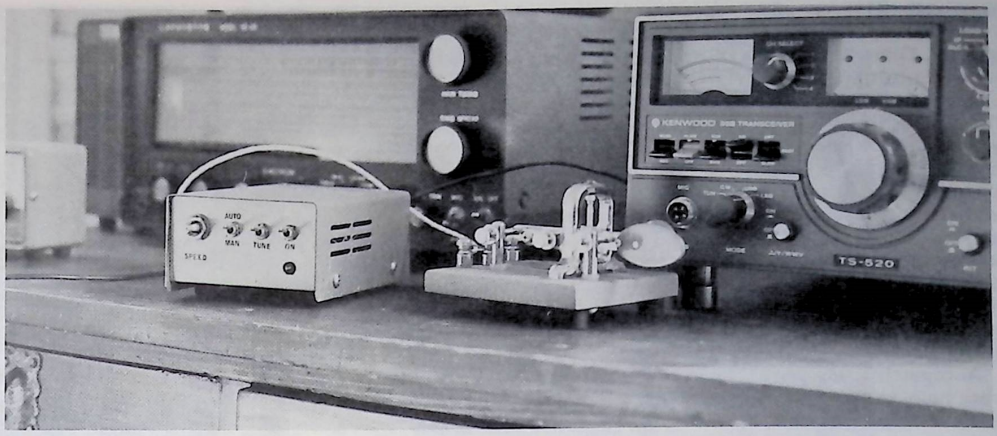
The operator is sending Morse code with a straight key.

QRA — What is the name of your station?
QRM — Is my signal being interfered with?
QRN — Is there static on my signal?
QRO — Shall I increase my power?
QRP — Shall I decrease my power?
QRQ — Shall I send faster?
QRS — Shall I send slower?
QRT — Shall I stop sending?
QRV — Are you ready for my transmissions?
QRZ — Who is calling me?
QSB — Are my signals fading?
QSL — Will you acknowledge this contact?
QSO — Can you contact ?
QSY — Shall I change frequency?
QTH — What is your location?

Table 2-1. Commonly used Q-Signals.

ABT — about
AGN — again
BUG — semi-automatic key
B4 — before
C — yes (correct)
CQ — calling any station
CUL — see you later
CW — morse code
DX — distance
FB — fine business, excellent
FREQ — frequency
GB — good-bye
GE — good evening
GM — good morning
GN — good night
N — no
PSE — please
RFI — radio frequency interference
SKED — schedule
TNX — thanks
WX — weather
73 — best regards
88 — love and kisses

Table 2-2. Abbreviations make code messages short and easy to send.



Paddle (right) and keyer (left) make sending Morse code easy.

played over your AM radio and FM radio, can't you? FM sounds so much nicer. And since static, car ignition noises, and other interfering sounds are amplitude modulated (AM), your FM radio will not pick them up. (Ah, that's why my FM car radio sounds better than my AM!) Add them all together and you have a lovely way to communicate.

Repeaters

Since FM signals on higher frequencies (which rarely bounce off the atmosphere) are line-of-sight, a new form of communication has grown which extends FM coverage: *repeaters*. A repeater receives and then retransmits an incoming signal. Repeaters are placed at high elevations. In New York City, for example, a repeater in one of the Chrysler Building's top floors, gives coverage of 15 miles and more to hams using only small low-powered hand-held units (Fig. 2-2). Think of it ... sitting in a Long Island park with a walkie talkie, you can talk to someone relaxing in his New Jersey backyard, also using a small walkie talkie. A distance of over 20 miles with perfect voice quality.

About 2000 repeaters throughout the United States and about 100 more in foreign countries, are built and maintained by clubs. More than 85% of all hams use repeaters and it is a boon for the motorist who can use them for traffic reports and emergencies, or just chatting with friends.

Some repeaters feature *autopatch*. The operator connects a Touch Tone pad to his transceiver and then punches up the telephone number he wants. The repeater, wired to the phone lines, accepts and decodes the numbers he transmits. He then talks through his transceiver, through the repeater, to the party on the telephone. This not only permits access to any phone for non-business calls, but lets the

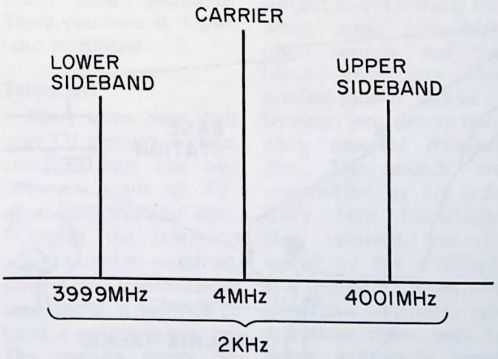


Fig. 2-1(a). AM signal.

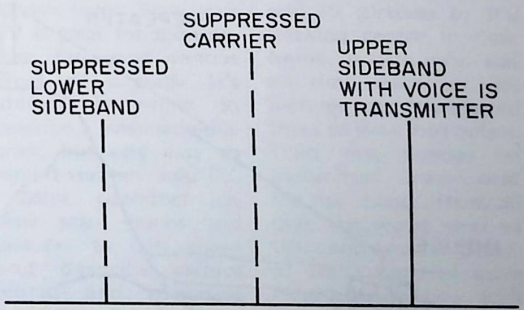


Fig. 2-1(b). SSB signal.

ham call 911 or any emergency number directly. Other fun things hams do with their repeaters and Touch Tones: push "#" and get a pre-taped weather report; "*" to get the time; "6" and get a recorded announcement of ham events; "7" gets you propagation reports, and lots more. The possibilities are infinite; hook up whatever you like to the repeater.

Autopatch is always a great help to hams especially for emergencies. In Chicago, one of the repeater groups works with the police department by relaying emergency messages from hams via autopatch repeaters. In fact, aside from the police department cars, which have direct access to the dispatcher, hams using this special service provide the most direct communications link to the police.

Some hams have placed Touch Tone pads on their handie-talkies. Specially made touch tone pads, which are extremely thin, are built into the back of the portable unit. The front of the unit, of course, is where the microphone-speaker is located. The operator, after accessing the repeater, merely presses the correct sequence of numbers, which turns on the auto-

Pictures sent by slow scan television.

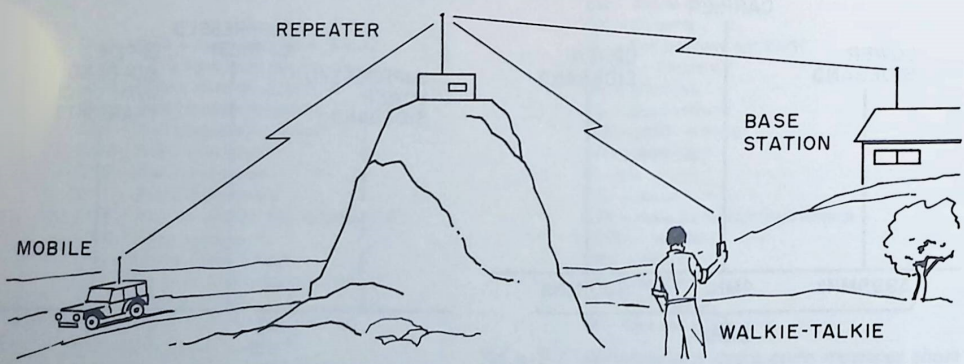
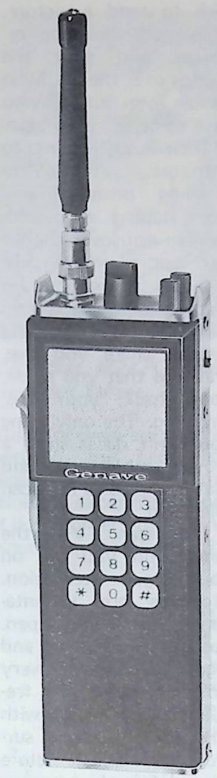
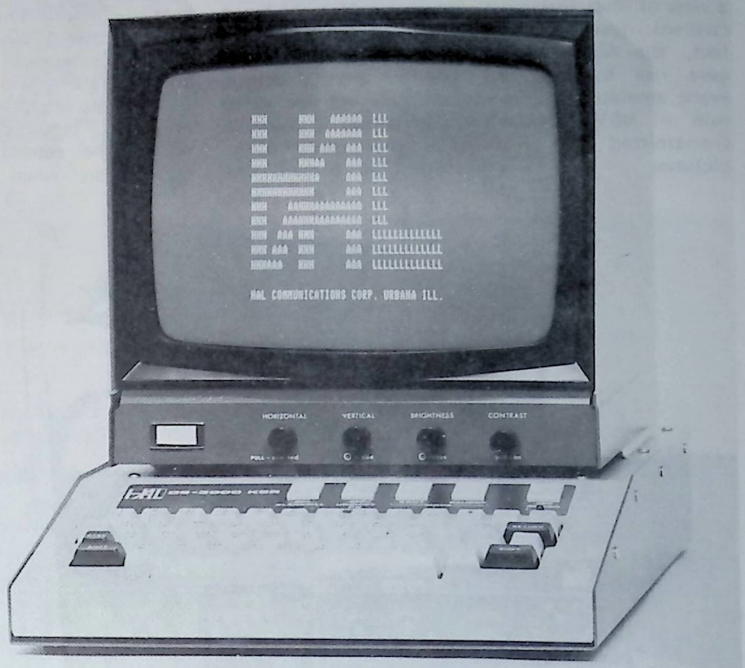


Fig. 2-2. Repeaters extend VHF transceiver ranges.





Instead of conventional teletypes, some hams use TV screens to print messages. The keyboard for transmitting messages is below it.

Walkie-talkie with a Touchtone pad for using repeater autopatch facilities.

patch. Then he presses the telephone number as if he was using a regular touch tone telephone. There you have it, a portable telephone.

Television

Many hams have their own TV stations. In fact, amateurs can use *two* different kinds of TV: slow scan and fast scan.

Unlike the television you are used to watching, slow scan transmissions take about 8 seconds to form a complete picture. The picture starts developing at the top left and scans to the right. Each line adds more. When the last line is received, the whole picture is complete. In brief, here is how slow scan TV works: a special camera takes a picture of your subject and translates the white areas into high pitch sounds and the black areas into low pitched sounds. Shades in between are proportionately assigned frequencies. The sounds are transmitted by an ordinary ham transmitter then received and decoded by the recipient. His monitor takes the decoded sounds and translates them back to lights and darks which form a picture.

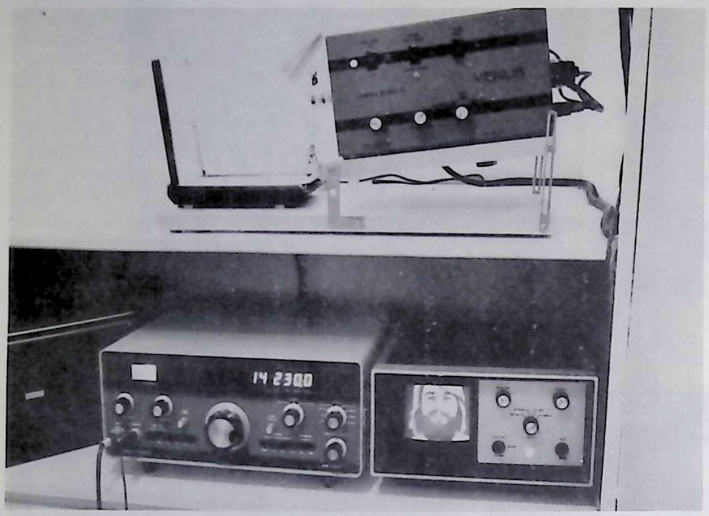
There are so many things you can do with slow scan television. Many hams use it to show other operators their equipment and themselves. Showing your neighborhood is especially interesting to foreign hams. Slow scan TV is great for showing, then discussing various types of circuits. It's almost impossible to describe a schematic diagram, but very easy to send it via ham radio TV.

Some operators use slow scan graphs and pictures to talk about and describe various world and ecological problems. For instance, one worldwide roundtable talked about the food shortage. The discussion was enhanced by graphs of food sources and population distribution.

Slow scan television let hams see views of Mars taken by the first *Viking* lander. The spacecraft sent its pictures to the tracking center in California. A ham who was on duty recorded the pictures and transferred them to slow scan pulses. Then, one Sunday he transmitted them over the ham bands. Hams all over the world received them and saw the surface of Mars. Many of them recorded the slow scan pulses and played them for other hams they later contacted. Ham radio

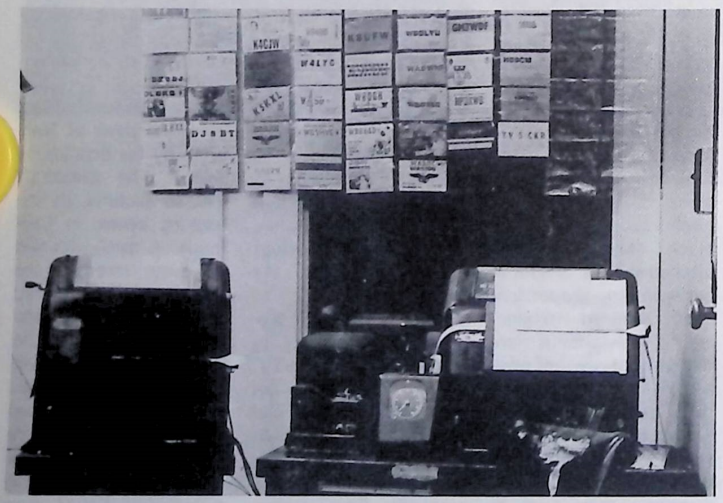
operators were treated to a view of Mars that most civilians never saw. In fact, the Mars landing gave rise to a special event amateur radio station — N6V — which transmitted the Mars pictures.

Slow scan gear is not expensive. You can buy a brand new monitor for under $250 and a used one for less. Of course, you can opt for home construction if you like. The other piece of equipment, the camera that takes pictures and translates them into sounds, can cost over $250. But you don't have to get one. Here's why: Go to a friend who *does* have one; take pictures and record the sounds on tape. Then, when you wish to send a picture, whip out the tape recorder and play the sounds over the air. Most hams, even those who have cameras, make tapes of their favorite scenes to transmit later. And nothing prevents you from taping a picture sent to you over the air and retransmitting it. This is how you build a picture library. Slow scan is great for showing people where you live, drawings that you made, your shack, your dog, anything. The only thing you can't do is show a moving subject . . . and that brings us to fast scan television.



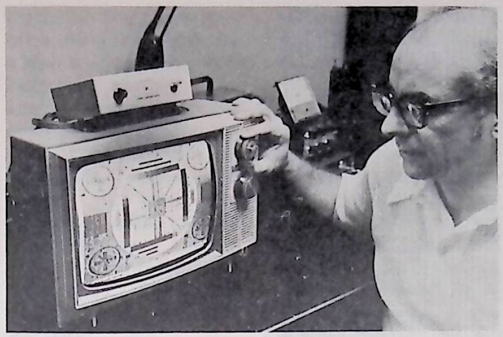
Slow scan monitor, camera and transceiver at station VE1BFL in Canada.

Fast scan TV is the same kind you see on your regular television. Pictures are instantaneous — as they happen. Fast scan equipment and regular television are very close in design and frequency. Old TV sets with UHF channels and surplus department store 'shoplifting' cameras, work well in amateur use.



Two teletypes used by MIT's radio club-station W1MX.

Unlike SSTV which takes up little bandwidth, fast scan takes up lots of room. Therefore, transmissions are confined to Ultra High frequencies where less stations operate. Unfortunately however, these frequencies are usually line-of-sight and worldwide transmissions do not occur. (Slow scan pictures go all over the globe because they use the lower frequencies.) Again, hams build special repeaters to extend ranges. One repeater, dubbed "Metrovision," in Washington, DC, got special FCC permission to operate. Amateur fast scan repeaters are new and FCC

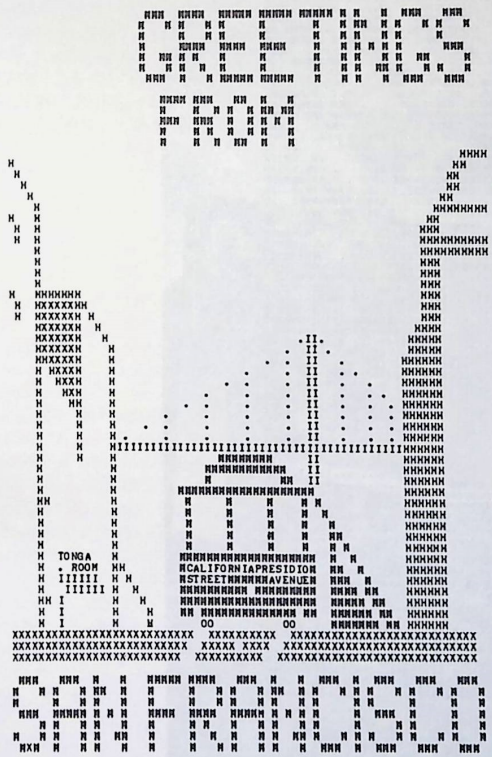


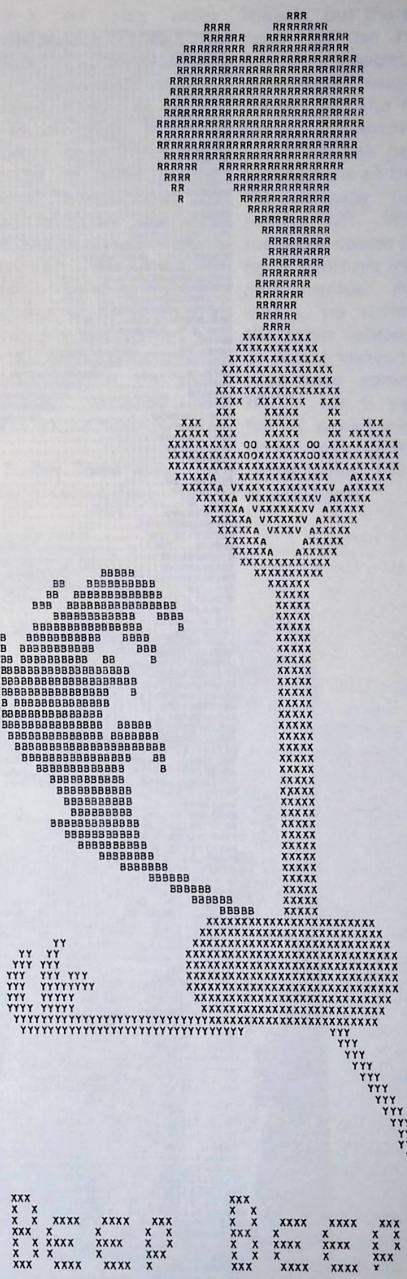
Ed Pillar W2KPQ receiving fast scan pictures on modified TV set.

rules for them are not yet written, but hams got approval to allow continued experimentation. Like conventional TV, sound accompanies the picture. It's lots of fun to have your own TV show!

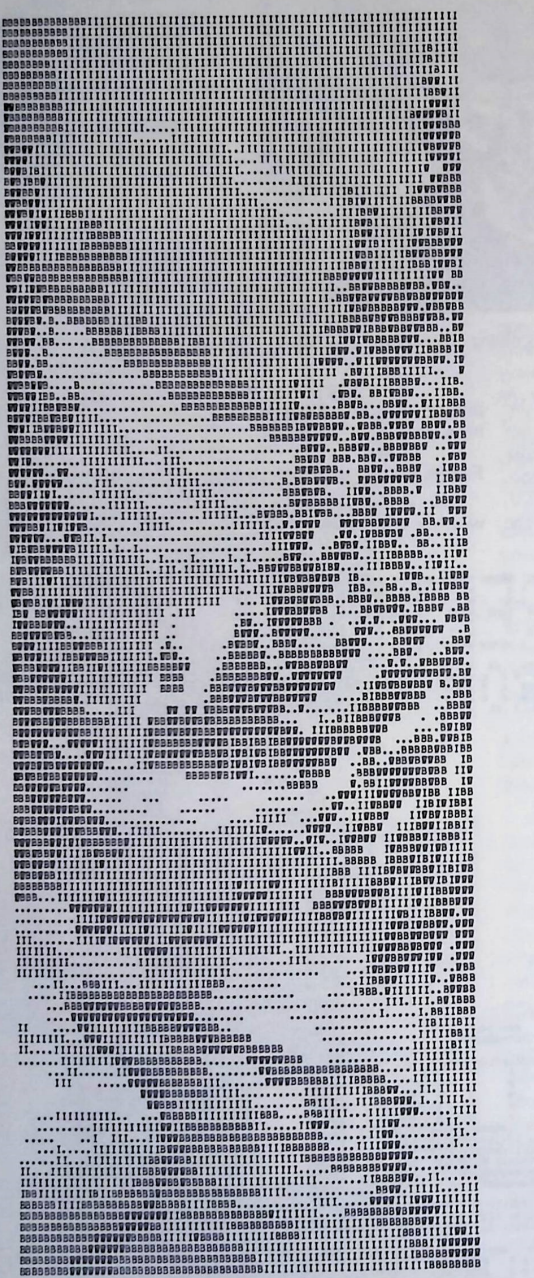
Facsimile

Did you ever see the weather maps drawn by a





Examples of RTTY art.



More RTTY pix.

machine? The paper rolls off a drum and is shot by a steel stylus which spews electrical charges. The special paper changes color depending upon the amount of charge it receives. By varying the charge, we can form pictures. Similar to slow scan techniques, varying the transmitted frequencies produces varying shades of light and dark.

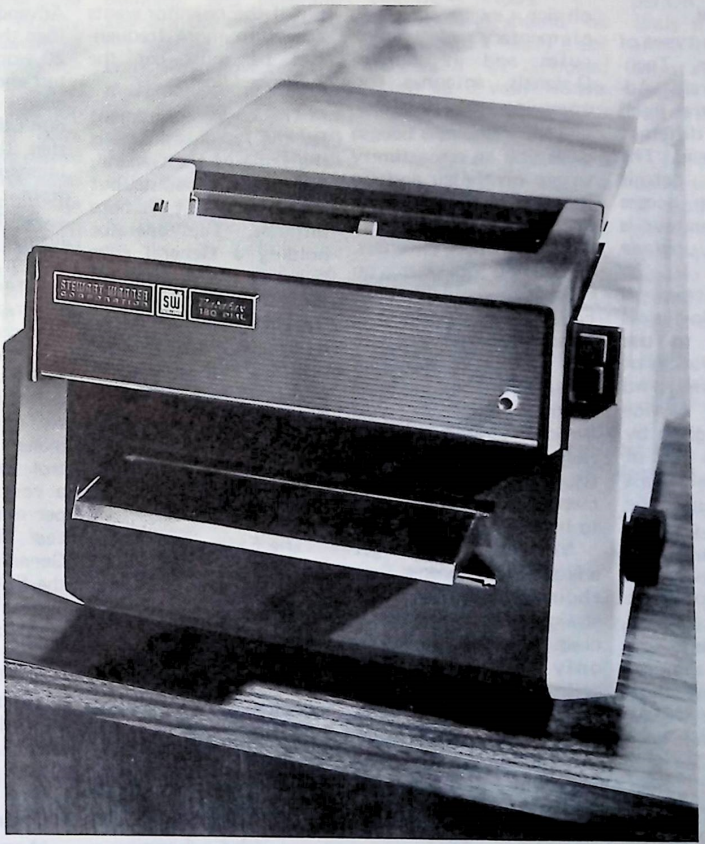
The system, called facsimile or FAX, is also used by police departments to receive pictures of criminals from other departments around the country.

Converted surplus FAX machines make sending pictures a snap.

Teletype

Bitten by the teletype bug, hams converse by pecking keyboards and having yards of paper printouts lining their floors. Yes, it's the same teletypes you see in newspaper offices, and they work the same way except hams use the airwaves instead of wires to transmit messages. Teletype or RTTY for radioteletype is not new; hams have used it for years. Newer models don't have the earth shaking clankclank of the older machines. They are quieter. But many hams don't use them either. Instead, they use silent screens. The message appears on a TV screen instead of paper. If he wants "hard copy" to read later, he can tape the sounds and play them through his monitor again. Sending RTTY pictures (PIX) is an artform. By combining letters and punctuation marks in just the right positions, detailed pictures are formed.

Some hams keep regular schedules with friends, but the recipient need not be home to receive messages. A predetermined frequency is chosen and the incoming message automatically turns on the printer. A special tone at the end of the message turns the printer off. When the recipient comes home, he reads what his friend sent and replies. Again, it makes no difference if the other fellow is home or not. I know two hams who have conversed by RTTY for 9 years; one fellow works nights, the other days; neither one is home when the message is being sent.



A modern facsimile machine.

Chapter III

The License

Getting a License

There are five types of licenses: Novice, Technician, General, Advanced, and Extra. Each one allows different operating privileges. The higher classes permit greater spectrum access and thus the amateur is encouraged to upgrade his class.

Most hams start as Novices. The Novice is permitted only to use code for the duration of his license. There is no charge for the Novice license and it is given by mail only with a ham of at least General class license proctoring the exam. The test consists of a Morse code section and a basic theory section. The applicant must send and receive Morse code characters at 5 words per minute. That's not very fast when you consider that if you just *know* the letters you will already be going at 5 words per minute. The second part of the test, the theory section, is a very simple multiple choice exam covering elementary electronics, rules and regulations, Q-signals, antennas and operating procedure.

The Novice license gives you an opportunity to get on the air and see if you like ham radio enough to go for the higher class licenses. Once you operate, you will see how quickly your code speed shoots up. Before you know it, you will be able to copy fast enough for the next class license. Also, as you become familiar with radio gear in day to day situations, the General class theory will be easier to handle.

You do not have to get a Novice class license first though. You can go straight for the General class. The test, which is only given at FCC offices, consists of the same format as the Novice but with a code requirement of 13 words per minute and a harder theory test. The General class holder is allowed all ham privileges and modes but if the operator wants access to more frequencies he must get the Advanced license.

The code requirement for the Advanced class is the same as the General, 13 words per minute, but the theory test is more difficult. The operator holding a General class ticket need not retake the code test again, only the new theory exam. Some applicants even dispense with the Novice and General licenses. They go to the FCC office, take the 13 wpm code test, the General theory test and then the Advanced theory test.

The Extra class license is the pinnacle of hamdom. It allows the holder to use all the radio frequencies assigned by the FCC to amateurs. As with anything else, the less people occupying the area the more desirable the space. But more than that, the Extra class license is a mark of distinction. The Extra class exam calls for holding an Advanced license first, then the applicant takes a 20 word per minute code test and a theory exam of greater difficulty. But don't think for a moment that the Extra class is impossible to get. It's far from it.

Another available license class is the Technician. The class was started to stimulate interest in the frequencies above 6 meters, the VHF and UHF regions. It is also obtained by hams who want to operate model airplanes using radio control. The test consists of a code test of 5 words per minute and a theory test identical to the General exam. Recently, the FCC permitted Technicians their own privileges plus those of the Novice license. Therefore, Techs can operate any mode above 6 meters and Morse code in the Novice bands of 80, 40, 15 and 10 meters.

The Code Test

Many prospective

hams are turned away from ham radio because of the code requirement. I don't know why. Learning code requires only time, patience and a positive attitude.

As you probably know, Morse code is composed of dots and dashes. The dots and dashes are used to form characters. Characters are letters, numbers and punctuations. The International Morse code, the one used on the ham bands, is not the same code that Samuel Morse devised. It's very similar, but Morse used different dots and dashes than we now use. For instance, in International Morse code the dashes are exactly three times the length of the dots. This holds for all characters. Morse, however, had a few letters which were composed of very long dashes — some up to five times the dot's length. Obviously, International Morse is much easier to send and receive because of this uniformity.

The first thing to do when you start learning the code is to think of the elements, dots and dashes, as dits and dahs. The code is an aural language and these sounds are close to the sound you hear on the air. The space between each element is equal to one dit. The space between each character is 3 dits, and the space between each word is 7 dits. The chart shows the dit-dah combination for each character.

Arranging the characters into groups makes them easy to remember. You can see the logical progression.

The code practice oscillator and telegraph key are the best way to get started learning the code. First, however, you must adjust the key for your touch. The key contacts should be about 1/16 inch apart. This is not absolute, only a rough estimate. Be sure to loosen the lock nuts on the key before you adjust the spacing. Tighten all lock nuts when the spacing is correct.

Next, adjust the spring tension to suit your own taste. Some people like a heavy touch, others prefer it light. A heavy spring usually causes your sending to be choppy while a loose spring causes you to slur characters.

Sit upright in the chair and place your forearm on the table. Your wrist should be off the tabletop. How you grasp the knob is an individual choice, but start off with the forefinger on the knob and the thumb on the knob's side. Relax your arm and let your wrist do the work. Curl your other fingers.

The key should be fastened to a heavy piece of wood or weighed down so it won't move. This is very important for good sending.

Practice making a string of dits. Then a string of dahs. Then alternate dits and dahs. Try to maintain a steady rhythm.

This is a good time to listen to some tapes of perfect sending, just to hear how it sounds. Sending Morse code is like playing an instrument. The rhythm is more important than the individual notes.

73 Magazine sells tapes for all different speeds from beginner to advanced.

When you think you have memorized each character, try to copy the tapes. At first you will miss quite a few letters but in time your accuracy will increase. If you miss a letter, don't dwell on it. Go on to the next one. Later, go back and find the letters you had trouble with. Each person, as he learns code, finds that certain letters elude him, almost like a mental block. Don't despair — eventually you will get them all.

To practice sending code, the best thing to do is tape yourself sending nonsense letter groups like qwert yuiop. This assures that you can't memorize what you send. Another good way of

Group 1	
E	dit
I	di-dit
S	di-di-dit
H	di-di-di-dit
5	di-di-di-di-dit
Group 2	
T	dah
M	dah-dah
O	dah-dah-dah
Zero	dah-dah-dah-dah-dah
Group 3	
A	di-dah
R	di-dah-dit
L	di-dah-di-dit
W	di-dah-dah
J	di-dah-dah-dah
1	di-dah-dah-dah-dah
P	di-dah-dah-dit
Group 4	
U	di-di-dah
F	di-di-dah-dit
2	di-di-dah-dah-dah
V	di-di-di-dah
3	di-di-di-dah-dah
4	di-di-di-di-dah
Group 5	
N	dah-dit
D	dah-di-dit
B	dah-di-di-dit
6	dah-di-di-di-dit
8	dah-dah-dah-di-dit
9	dah-dah-dah-dah-dit
X	dah-di-di-dah
Group 6	
G	dah-dah-dit
Q	dah-dah-di-dah
Z	dah-dah-di-dit
7	dah-dah-di-di-dit
K	dah-di-dah
C	dah-di-dah-dit
Y	dah-di-dah-dah
Period	di-dah-di-dah-di-dah
Comma	dah-dah-di-di-dah-dah
Question Mark	di-di-dah-dah-di-dit
Error	di-di-di-di-di-di-di-dit

Table 3-1. Morse Code Characters.

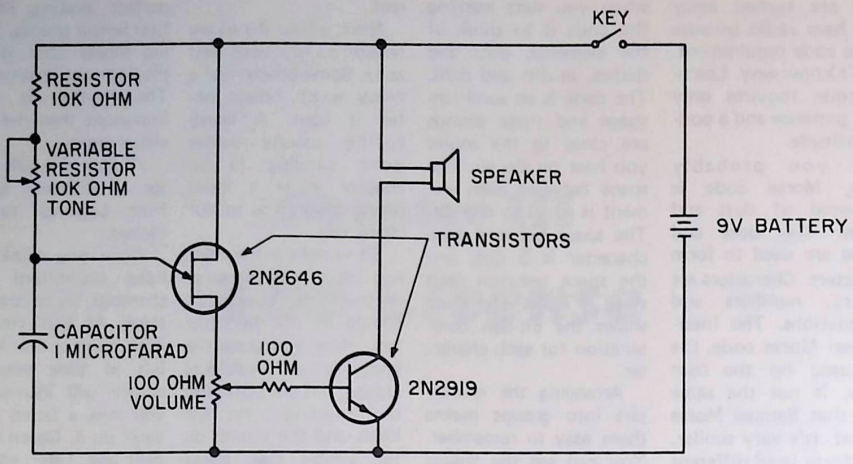


Fig. 3-1. A simple code practice oscillator.

learning code is to practice with a friend. This way you can help each other over rough characters and point out each other's weaknesses.

Before you actually take your FCC test, make sure that you can copy at least 3 or 4 words per minute more than the test requires. If you are taking the general test, which has a thirteen words per minute requirement, copy at least 15 at home. This extra margin comes in handy when you get nervous at the FCC office. An excellent way to study for your test is to try to copy hams off-the-air. Since people cannot send perfect code like the FCC code machine which gives the test, copying "real" people is a challenge.

If you can copy a non-perfect ham at 15 words per minute, have no fears of passing the General code exam.

The Theory Test

The best way to study theory is to read the books on ham theory. The tests vary from year to year, but the subject matter remains fairly constant. Even so, get a later edition book to study from.

If you have problems with the theory, perhaps you should join a class. Classes all around the country have been formed to help potential hams obtain their licenses. Very often the disciplined atmosphere of a class gives that extra push you may need to study the theory.

After you have a feel for the theory, read Part 97 of the FCC rules. This is the section which covers amateur radio. About 1/3 of the test is devoted to rules and regulations. The amateur rules have been changing rather rapidly lately and you should get the newest copy of the Part 97 that you can obtain.

Studying rules and regulations also helps you in theory, too, because many of the rules are technical rules. For instance, an amateur must be able to keep his transmitter free of extraneous signals. These signals are called harmonics and spurious radiations. Knowing that you must suppress these unwanted signals leads you to find out how to do so. Harmonic and spurious suppressions is always a test question.

When you think you know all you need to know, a question and answer book is helpful. The questions are the type that the FCC asks on the actual test. It is easier to take tests when you are familiar with the format before walking into the exam room. FCC tests are multiple choice: one out of five. You usually have plenty of time to answer them.

The License

The ham radio license is actually two licenses in one. It contains the Station License and the Operator's License. If your station is in your home, then you and your station have the same call letters. If you decide to have a station in someone else's house, all you need is another station license. You use the call letters of the station you are at despite your own operator's call sign. For instance, if I visit W1MX, the club station of the M.I.T. Amateur Radio Club, I use their callsign in any transmissions I make. But I can't use frequencies not assigned to my license class despite *their* license class. (Each club station has a trustee and the class of the station license is the same as that of the trustee.) That's if I am operating alone. If someone of a higher class than me is there, I can use privileges assigned to his or her license class. In fact, *anyone* can talk or send Morse code using amateur radio as long as a licensed operator is present. Your non-ham friends will love that rule.

Class	Code	Theory	License Period	Cost	Privileges
Novice	5 wpm	Elementary	2 yrs. renewable	Free by mail	Code only — segments of 80, 40, 15 and 10M band only
General	13 wpm	General	5 yrs. renewable	Free FCC Office	All modes & bands except freqs. reserved for Advanced and Extra
Technician	5 wpm	General	5 yrs. renewable	Free FCC Office	Code only on Novice freqs.; plus all modes & freqs. above 6M — excluding Advanced & Extra freq.
Advanced	13 wpm	Advanced	5 yrs. renewable	Free FCC Office	All modes & bands except freqs. reserved for Extra
Extra	20 wpm	More Advanced	5 yrs. renewable	Free FCC Office	All amateur modes, bands and freqs.

Table 3-2. Amateur License Classes.

Chapter IV

Equipment

It's a Rich Person's Hobby – Right?

The radio amateur is the only radio operator who may build, maintain and test his own equipment without FCC approval.

He is allowed to build any equipment he wants and use any type of antenna he chooses. He need not ask permission from the FCC, nor must his equipment be sent to the FCC for approval. He must, however, meet certain criteria. His transmitter must operate within the ham bands and not cause interference to any service, including the amateur service. It's a large responsibility, but the license shows you can do it. In everyday hamming, you have your own knowledge to tap and that of other hams you meet on the air.

Build or Buy

In the "old days" few hams bought their equipment because there was little available. These days most hams buy their gear because much is around at reasonable prices. But don't get the idea that hams don't build anymore. Although most amateurs buy their transceivers (combination transmitter and receiver), the bulk of building comes in peripheral equipment: meters, antennas, keyers, amplifiers, filters, etc.

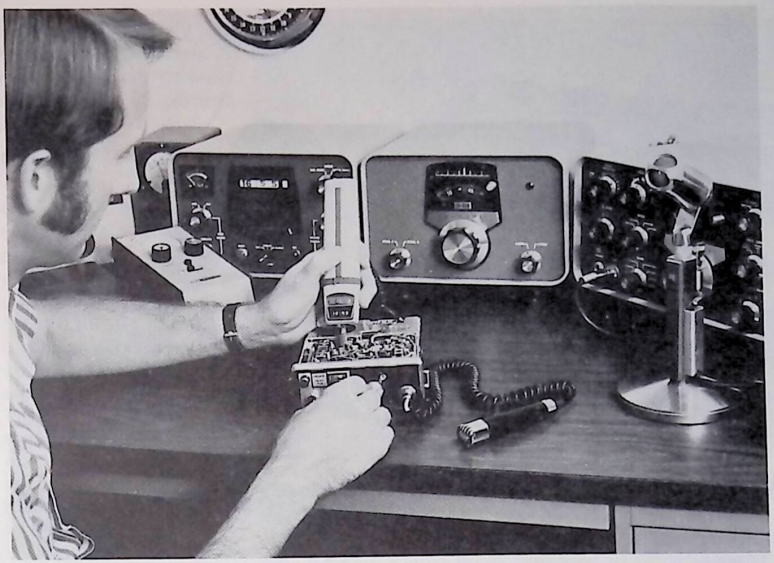
The build versus buy controversy rages. Some feel that you are not a true ham unless you build; still others claim that since there is so much good stuff around, you are foolish not to use it. The fact is, if you want a certain piece of gear you will look at the available items. If nothing is around and you have the time, you construct it. If, however, the gear is commercially made and reasonably priced, why not buy, unless of course you want the challenge of building. In the early days of slow scan TV very little was available, so hams built their own. As it became more popular, commercially made items came on the market and it became cheaper and easier to buy than build. Right now, very little is available in fast scan TV at a reasonable price; so most hams build. In the near future, it will be more popular and easier to buy.

Very often you build an item because you have the most expensive component on hand. Many hams still build their own slow scans because they already have the cathode ray tube (the screen) or some printed circuit boards which contain most of the needed circuits. It's a trade-off of time, money and patience.

Most hams started in short wave listening. They used their skills about propagation conditions to listen for distant and rare stations. It requires great knowledge and patience. As time wore on, many listeners felt they would also like to transmit and so they got licenses. The techniques they brought with them to ham radio served them well. An old ham radio adage says, "Before you can work them, you have to hear them." Having the receivers they already owned, all they needed was a transmitter to round out the station. Actually, building a transmitter for Morse code is easier than building a receiver. A low powered transmitter can be constructed with only three transistors. The power is low, but with a good antenna and sharp operating skills, you can work the world regularly.

Surplus

This brings us to surplus gear. Hams convert transmitters and receivers used by the military or commercial sector. It's simple to change these units to ham use because most of the workings are already there. And price is the best part. Surplus radios can be bought very cheaply. Again, the



Test equipment makes tuning and aligning your equipment easy.

license allows you to take the equipment, test, adjust and rebuild to get it working as ham gear.

In the pioneer days of 2 meter FM, hams converted surplus police and fire transceivers. The police frequencies were so close to the 2 meter band that conversion was often just a matter of retuning and realigning. When 2 meter, commercially-made gear came on the market, they were those very same police and fire transceivers put into new cabinets and adjusted for the ham band. The inner workings were basically the same, yet the surplus gear cost about $25 and the ready made custom 2 meter unit cost $150 – $200. Of course the surplus gear had only one or two channels, but a little ingenuity corrected that.

Kits

If a ham doesn't want to start from scratch, kit building is an alternative. The builder, supplied with parts which include chassis, cabinet and instruction manual, comes out with a highly advanced piece of equipment. The main advantages of wiring your own kit are low cost and satisfaction of doing it yourself. Some claim there is little difference between buying all the parts separately and using a magazine or book project as an instruction manual, or buying a kit. Both take skill, but a kit saves the trouble of tracking down all the parts, a time consuming task.

Kit construction teaches you an enormous amount about the equipment, and if anything ever goes wrong, you have all the knowledge needed to set it right again. That is a great asset.

Buying

As with many store-bought items, the more expensive, the better the performance. With ham gear it holds true, but with added expense come more features. Decide what features and extras you want before you buy. A good time to look is after you pass your test. Before your license arrives in the mail, you have time to peruse the market and when your ticket arrives you can get on the air immediately. Talk to other hams, ask around, see what they prefer and why. Ham magazines have plenty of ads for transceivers, and manufacturers are happy to send additional information. Armed with the knowledge you got by studying for the license, you can interpret specifications listed on brochures.

Don't rule out buying used gear. Very good bargains are found this way. If you are not familiar with a particular piece of equipment take a more knowledgeable ham with you. Try it; get on the air with it. Check the condition; see if it is abused. Like making any other purchase, use your common sense. Most hams you will find take good care of their equipment because they know that someday they may sell it. There are always those who must have the latest gear and those who, for no reason, tire of looking at the same dials. They sell excellent gear at low prices just to change the scenery in their rooms. Be wary of exceptional deals, but don't pass one by just because it seems "too good."

As you see, there is great leeway in ham equipment – new, used, kits, surplus and all those hybrids in between.

Accessories

Some hams have equipment piled high to the ceiling. Others use only the basic transceiver. Most hams lie somewhere in between and accumulate a great deal of accessories over the years. These accessories enhance your station by making operation easier and more efficient. In fact, you can hardly call many items extras, some are absolutely necessary.

The Dummy Load

The dummy load is a device which takes the place of an antenna. It is used when you want to operate your transmitter but don't want to put a signal out over the air

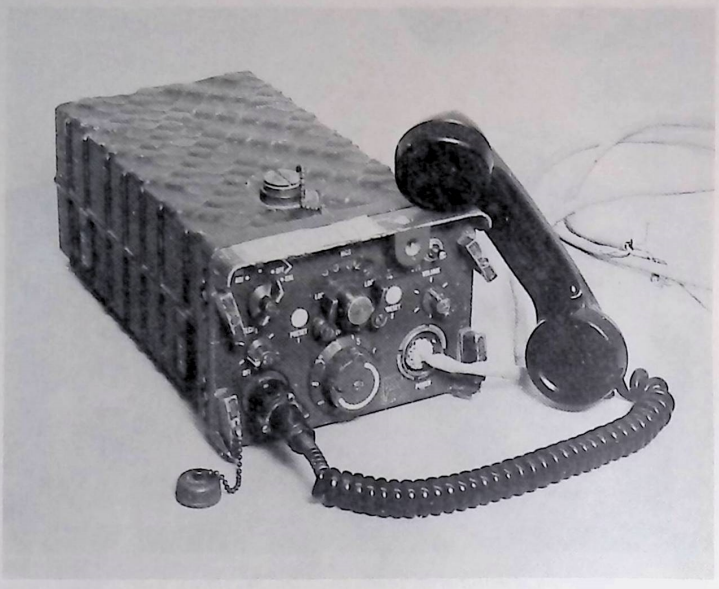
which could interfere with other conversations. Not interfering with other hams is part of ham etiquette and is discussed more fully in Chapter 6.

Some dummy loads are just big resistors which are immersed in mineral oil. The resistor absorbs the transmitter's energy, letting none of it escape. More elaborate dummy loads have built-in power meters which measure your output power. Dummy loads come in all power ratings and usually cost from $15 to $50.

The SWR Meter

The Standing Wave Ratio meter, sometimes called an swr bridge, is placed in the transmission line between the transmitter and antenna. It measures how well your antenna matches your transmitter. For maximum power to be transferred into the antenna, both antenna and transmitter must have the same impedance. That is, they must have the same resistance to the current which flows through them. When they are matched, (the impedances are equal) your antenna is most efficient. When they are mismatched, your power is not reaching the antenna but being converted to heat energy in the transmission line.

This requires us to trim the antenna to a proper length. For the most part, antenna length determines its impedance. Other factors come into play, but they are too complicated to discuss now. Anyway; by trimming our antenna, while watching the swr meter, we match antenna and transmitter very closely.



This Army surplus transceiver was converted to ham radio use.

The swr meter is designed to read the ratio of impedances between antenna and transmitter. Ideally, we would like that ratio to be 1:1. We cannot always come this close and readings of less than 2 or 2.5:1 are acceptable. Along with the ratio, the meter is also calibrated to read the percent of "reflected power." As you can see by the meter dials, the higher the ratio, the more power is reflected back. And it works non-linearly. Reflected power

A modern 80-10 meter transceiver.

increases drastically as the swr ratio increases. A ratio of 3:1 corresponds to a loss of 25 percent power. (Fig. 4-1.)

Low Pass Filter

This is one accessory which every ham should own. This filter suppresses harmonic radiation above a certain frequency (usually 35 MHz for 160 through 10 meter operation) so your signal will not interfere with a neighbor's television. Television frequencies start at 54 MHz. If you operate on 28 MHz, your second harmonic, 56 MHz, could cause interference.

By using carefully designed components, low pass filters pass only those frequencies which are lower than its "cut-off" frequency. In our example, the cut-off frequency is 35 MHz; signals higher than 35 MHz will not be transmitted.

Low pass filters are relatively cheap, about $8, and come in various power ratings to match your transmitter.

Field Strength Meter

The Field Strength Meter measures the relative output power of your antenna. It is placed near the antenna while you transmit. Although it won't read the real output power, it gives a good indication of where your signal is strongest, i.e., the direction, such as north or west. These types of measurements are important when you want to maximize your power output towards a certain area of the country or world. For instance, a beam antenna projects more power in one direction than the opposite direction. The ratio of how well it does this is called a *front-to-back-ratio*. The FSM is first placed in the front of the beam, then the back. The two readings are compared and the front-to-back-ratio calculated.

This transceiver is built from a kit.

The FSM is also useful when you operate from your car or boat. In mobile operation, antenna placement is critical. Your radiation pattern (how your antenna radiates) varies according to whether it is on the front of the car, on the bumper, or on the trunk. By knowing which way your signal radiates best, you can turn your vehicle towards the station you are talking to for maximum effect.

Earphones

Never underestimate the power of earphones for pulling in those weak stations. It is not uncommon for you to hear stations while using earphones that you can't hear using a speaker. This is because surrounding noises obscure weak stations. Earphones, however, let you hear the stations "closely" without outside noise interference. Also, using earphones keeps your mind concentrated on the station you are listening to and allows no outside diversion to steal your attention.

And, of course, let's not forget the social and family value of earphones. Earphones let you operate your station without disturbing your family and neighbors.

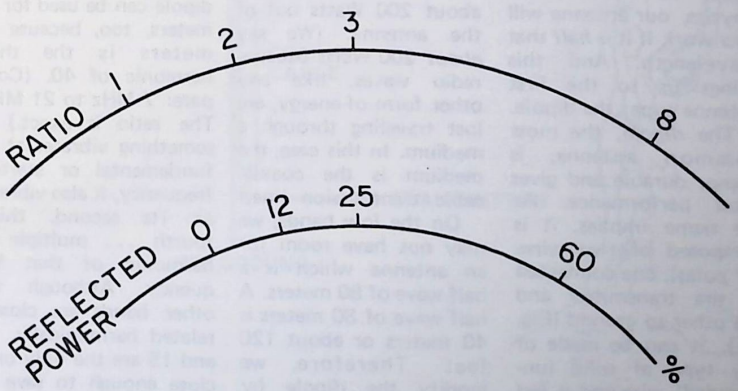


Fig. 4-1. SWR meter dial.

Chapter V
Antennas

But What If I Don't Live On a Large Farm?

The antenna you choose depends upon your own interests in ham radio and the available space you have. Since antennas resonate at certain frequencies, they must be specific sizes to work properly. For instance, if we operate on the 20 meter band, our antenna is 20 meters long, or about 66 feet. But according to a quirk in the law of physics, our antenna will also work if it is *half* that wavelength. And this brings us to the first antenna type: the dipole.

The *dipole*, the most common antenna, is cheap, durable and gives good performance. As the name implies, it is composed of two wires (or poles), one connected to the transmitter and the other to ground (Fig. 5-1). It can be made of any type of solid (unstranded) wire and is fed by a wire called *coaxial cable*. This special type of transmission wire is shielded by braided wire. Shielding allows little energy to escape on the way to the antenna, and most of our transmitted power goes right where we want it to. The dipole works best for stations you talk to that are at right angles to it, that is, broadside.

The dipole is known as a unity gain antenna. This means that if we put 200 Watts into the coaxial cable we get about 200 Watts out of the antenna. (We say *about* 200 Watts because radio waves, like any other form of energy, are lost traveling through a medium. In this case, the medium is the coaxial cable transmission line.)

On the low bands, we may not have room for an antenna which is a half wave of 80 meters. A half wave of 80 meters is 40 meters or about 120 feet. Therefore, we modify the dipole by putting a stick or pole in the middle, decreasing the horizontal length (Fig. 5-2). It is then called an *inverted "V"* and has the same characteristics as the dipole but takes less space.

So far we have talked about antennas for just one band. What if we want to work more than one? We can erect a separate dipole for each band, but an easier solution is to add on to the existing one (Fig. 5-3).

We get a little help from physics: a 40 meter dipole can be used for 15 meters, too, because 15 meters is the third harmonic of 40. (Compare: 7 MHz to 21 MHz. The ratio is exact.) If something vibrates at its fundamental or starting frequency, it also vibrates at its second, third, fourth ... multiple or harmonic of that frequency. Although the other bands are closely related harmonically, 40 and 15 are the only ones close enough to save us antenna wire.

Verticals

Another popular type of antenna is the *vertical ground plane* (Fig. 5-4). In a sense, it is a dipole turned on end at the center. A main advantage is the low angle of radiation that it generates against the horizon. Because long distance communication relies on bouncing off the atmosphere, the vertical is ideal for working faraway stations. Like the horizontal dipole, it adds no power to the outgoing signal. What goes in, comes out.

Trap Dipoles

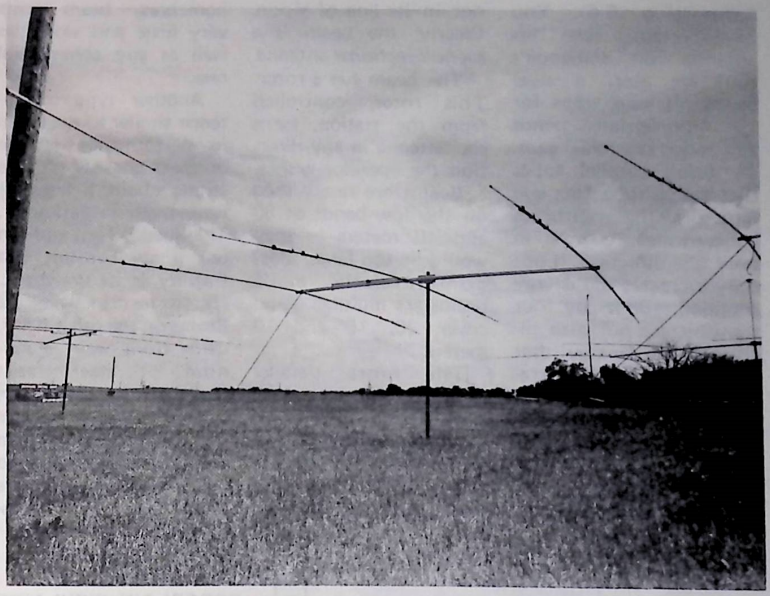
If we could fool the transmitter into thinking it is pumping power into an antenna of a half wavelength when it really isn't, we could save an awful lot of antenna wire. Well, we *can* do it with a system employing *traps*. These traps are combinations of coils and capacitors which resonate at the desired frequency, allowing us to use less

than a half wave antenna (Fig. 5-5). Not only can we shorten our antenna, we can put several traps for different bands on one wire and have a "multiband" antenna.

Multiband trap dipoles look very much like ordinary monoband dipoles but have bulges, which are the traps, along its length. It, too, can be placed in the inverted "V" configuration if the full horizontal room is not available. The trap technique is also applied to verticals. Thus, only one rod and corresponding radials are needed for the 80-10 meter bands.

Beams and Quads

The best antenna for working distant stations is undoubtedly the trap



A group of 3-element beams.

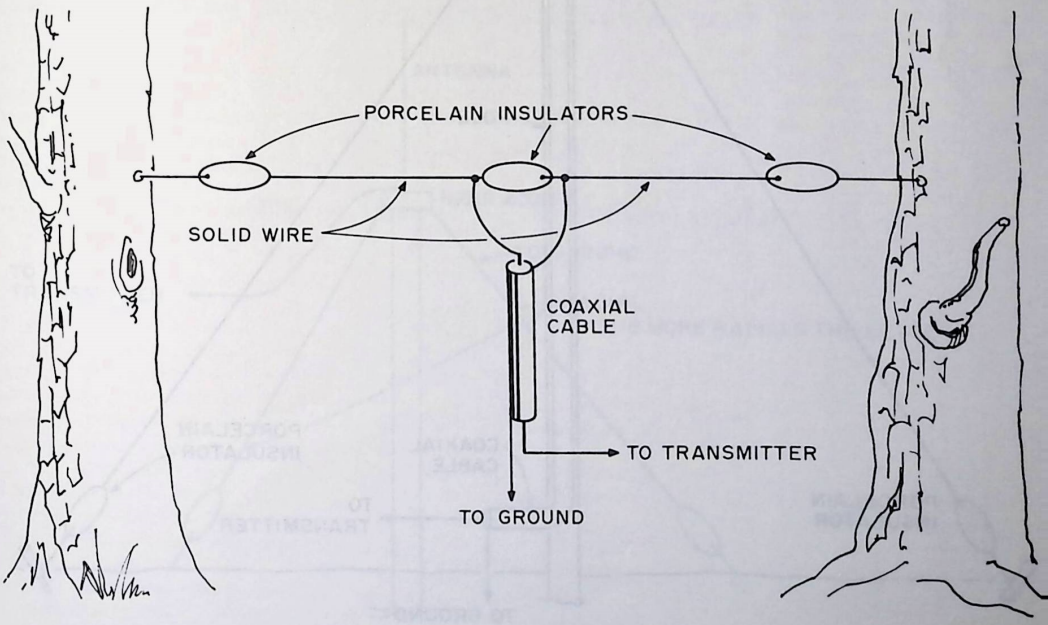


Fig. 5-1. Dipole antenna.

beam (Fig. 5-6). You have certainly seen this antenna on someone's roof or atop a steel tower. It uses traps for the appropriate bands and also provides *gain*. By using parallel tubes that act as reflectors and directors, the trap beam concentrates energy in only one direction. It not only increases the energy supplied to it by our transmitter, but also increases the energy that comes from weak stations that you are trying to hear. This directional characteristic makes weak stations stronger and eliminates signals from unwanted stations not in its line of vision. Clearly, the beam is a *monodirectional* antenna.

The beam has a rotor. This rotor, controlled from the station, turns the antenna in any direction the operator wishes.

Beams are rarely used on the low bands of 80 and 40 meters as they would be too large. Most commercially made beams are multiband and cover 20, 15 and 10 meters.

The more parallel elements, the more gain and directionability you have. It is not uncommon to see homebuilt beams either. If you have the time and ambition, a homebrew beam costs very little and works as well as any commercial one.

Another type of antenna similar to the beam in performance is the *quad*. It consists of wire strung about a frame 1 wavelength in perimeter. The quad is light and can use a small rotor, but fragility is its drawback. Ice storms can wreck it. Beams on the other hand, made from heavy aluminum or steel, resist weather hazards. But again, the quad is smaller than a comparable beam and easier and cheaper to build. Each antenna has advantages and disadvantages.

Don't get the idea that these are the only kinds of antennas; they aren't. There are plenty of other designs and configurations, and hams continue to invent new ones all the time.

Unfortunately, some prospective hams are discouraged because they live in apartments and feel that they will not be able to erect an adequate antenna. While the cliff dweller may not be allowed to put up the ideal antenna, with ingenuity he can put out a decent signal and work lots of foreign hams.

First, let's discuss the

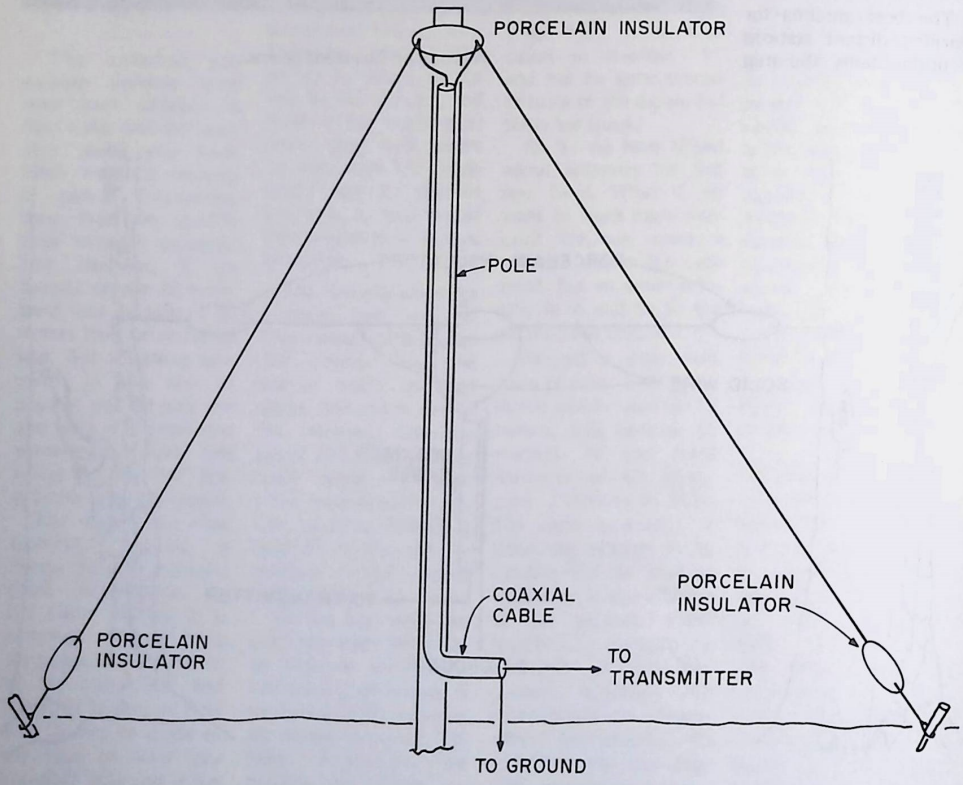


Fig. 5-2. Inverted "V".

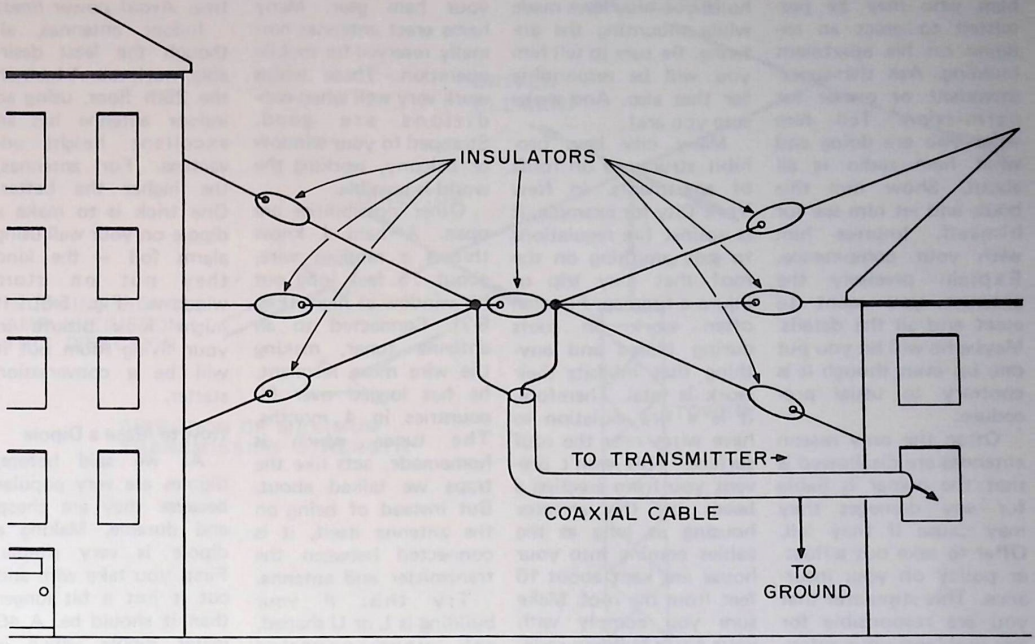


Fig. 5-3. Multiband dipole antenna.

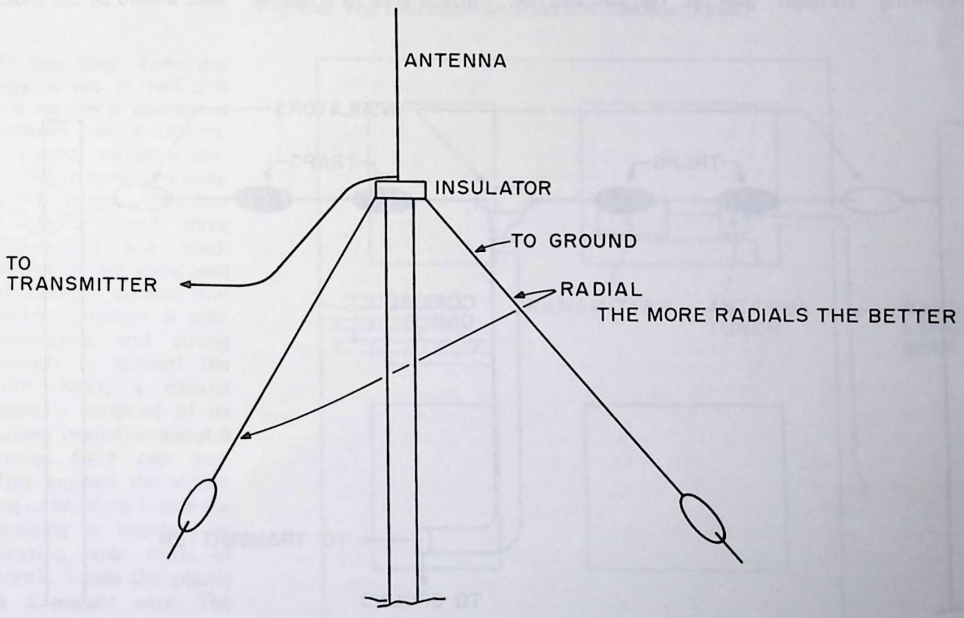


Fig. 5-4. Vertical antenna.

ham who *may* be permitted to erect an antenna on his apartment building. Ask the superintendent or owner for permission. Tell him what you are doing and what ham radio is all about. Show him this book and let him see for himself. Impress him with your competence. Explain precisely the antenna you want to erect and all the details. Maybe he will let you put one up even though it is contrary to usual procedure.

Often the only reason antennas are disallowed is that the owner is liable for any damages they may cause if they fall. Offer to take out a floater policy on your insurance. This stipulates that you are responsible for any problems your antenna causes. Owners are particularly fearful of water damage caused by rain coming through holes you may have made while mounting the antenna. Be sure to tell him you will be responsible for that also. And make sure you are!

Many city laws prohibit structures on roofs of apartments. In New York City for example, it is against fire regulations to put anything on the roof that may trip or injure a fireman. Firemen often work on roofs during blazes and anything that inhibits their work is fatal. Therefore, it is a fire violation to have wires near the roof surface. This won't prevent you from erecting a beam on the elevator housing as long as the cables coming into your house are kept about 10 feet from the roof. Make sure you comply with your city's building code.

If, however, your superintendent still disallows antennas, don't give up. You can still use your ham gear. Many hams erect antennas normally reserved for mobile operation. These whips work very well when conditions are good. Strapped to your window or balcony, working the world is possible.

Other possibilities are open. A ham I know throws a random wire, about 75 feet long out his window at night (Fig. 5-7). Connected to an antenna tuner, making the wire more resonant, he has logged over 50 countries in 4 months. The tuner, which is homemade, acts like the traps we talked about. But instead of being on the antenna itself, it is connected between the transmitter and antenna.

Try this: if your building is L or U shaped, ask your opposing neighbor if you can string a wire from your window to his or perhaps you can throw a wire to a nearby tree. *Avoid power lines!*

Indoor antennas, although the least desirable, work too. A ham on the 25th floor, using an indoor antenna has an excellent height advantage. For antennas, the higher the better. One trick is to make a dipole on your wall using alarm foil — the kind they put on store windows (Fig. 5-8). It might look bizarre in your living room but it will be a conversation starter.

How to Make a Dipole

As we said before, dipoles are very popular because they are cheap and durable. Making a dipole is very simple. First, you take wire and cut it just a bit longer than it should be. A 40 meter dipole which is approximately 20 meters long (dipoles are half wave antennas) or 66 feet, should be cut about

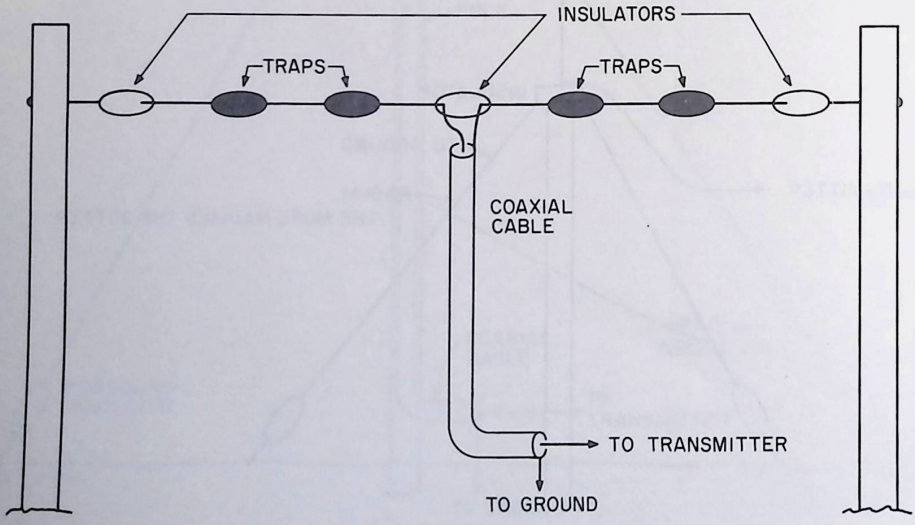


Fig. 5-5. Multiband trap dipole.

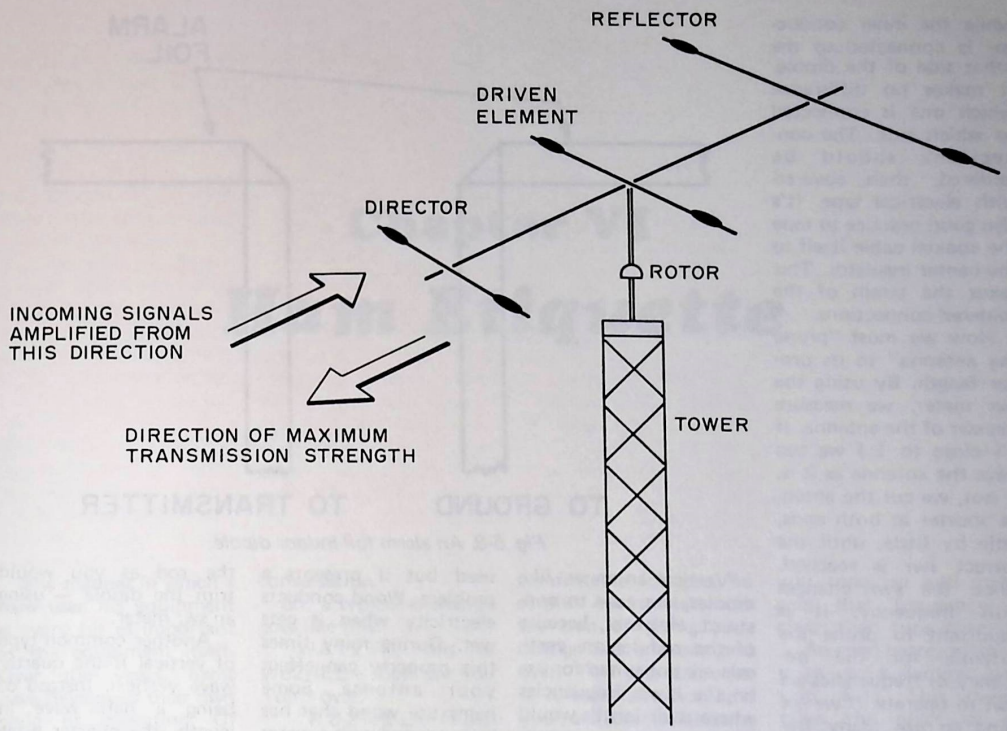


Fig. 5-6. The trap beam antenna is monodirectional.

67 feet long. Then the wire is cut in half and one section is connected between two insulators. The other section is connected to another insulator *and* to one of the first insulators. In all, three insulators are used. Insulators are composed of porcelain because that ceramic product is nonconducting and strong enough to support the wire. Next, a coaxial cable is stripped of its rubber insulation about 5 inches from one end. This exposes the shielding or braiding. Inside the braiding is another insulating layer made of plastic. Inside this plastic is a copper wire. The braiding is connected to one side of the dipole,

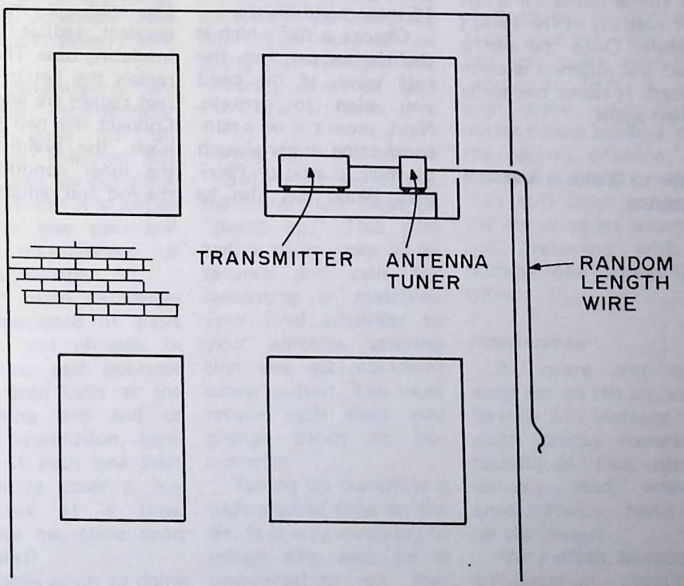


Fig. 5-7. A random wire used with a tuner works well.

while the inner conductor is connected to the other side of the dipole. It makes no difference which one is connected to which side. The connections should be soldered, then covered with electrical tape. It's also good practice to tape the coaxial cable itself to the center insulator. This takes the strain of the soldered connections.

Now we must "prune the antenna" to its proper length. By using the swr meter, we measure the swr of the antenna. If it's close to 1:1 we can leave the antenna as it is. If not, we cut the antenna shorter at both ends, little by little, until the correct swr is reached. Since the swr changes with frequency, it is important to prune the antenna for the frequency or frequencies we plan to operate. If we are going to use many frequencies within one band (and most hams do), we set the antenna for a low swr reading in the band's middle. Once the swr is low, the antenna is completed. It never has to be tuned again.

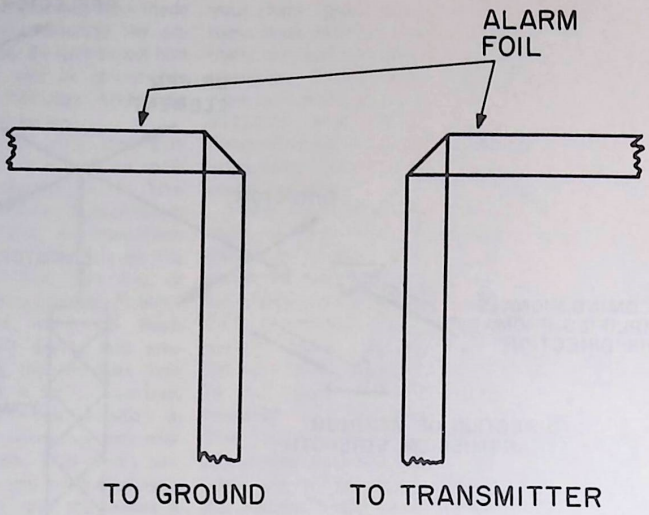


Fig. 5-8. An alarm foil indoor dipole.

How to Make a Vertical Antenna

Vertical antennas, like dipoles, are easy to construct. However, because of the rod length, verticals are not suited for use on the lower frequencies where their length would be too great to support. Verticals work best on the higher bands such as 15 meters and higher.

Choose a rod which is slightly longer than the half wave of the band you plan to operate. Next, mount it on a nonconducting material such as thick plastic or Plexiglas. Wood can also be used but it presents a problem. Wood conducts electricity when it gets wet. During rainy times this property can affect your antenna. Some hams use wood that has been treated with a water resistant coating such as urethane varnish. After the rod is mounted, connect radials to the insulating base. The more radials the better — but two radials are adequate. Connect the two coaxial leads, the braiding and the inner conductor to the rod and radials. Trim the rod as you would trim the dipole — using an swr meter.

Another common type of vertical is the quarter wave vertical. Instead of being a half wave in length, the quarter wave is . . . you guessed it . . . a quarter wave long. The radials are also a quarter wave long. The advantage, of course, is that you don't need a very long rod. A quarter wave vertical used for 15 meter operation is under 4 meters long, or about 7½ feet.

Chapter VI

Ham Etiquette

The manner in which a ham uses his equipment is every bit as important as the equipment itself. Over the years, hams have developed their own style of operating. Of course, this style encompasses the rules and regulations of the FCC. Good operating form not only makes communications possible but more enjoyable.

The rules require that a ham give his call letters at the beginning of the transmission. At the end of the conversation he must give the *other* ham's callsign and then *his* own. During the conversation each ham must give only *his* own callsign every 10 minutes. Simple.

Even though you only have to give *your* call at the beginning of the transmission, it is customary to give both your call and the other ham's call. This makes it easier for someone who is listening in to keep track of the operators in the conversation.

So, a typical exchange goes like this:

"WA1VTA this is WB2NEL — how are you Tom? over."

"WB2NEL from WA1VTA — just fine, I am using the new antenna and would appreciate a report. Go ahead." And the conversation continues.

If transmissions are kept short, each operator usually gives his call every ten minutes. But most hams are not clock watchers and it is just as easy to give your call every transmission, or every other one.

Very often, exchanges are composed of short replies and phrases. In that case, each operator gives both calls at the beginning and end of each transmission, especially if each one talks for more than a few minutes at a time. (Believe me, some hams can talk!)

It boils down to doing what you feel is right and comfortable for you. Be careful not to fall into the trap of giving your callsign over and over and over. This gets tiresome. It is especially boring if you are communicating under ideal telephone-quality conditions where the chances of not being understood perfectly are slim. The purpose of giving your callsigns, and knowing when to give them, is an art form.

Tuning Up

Before transmitting, the transmitter must be "tuned up." This procedure takes about 30-45 seconds and calls for resonating or matching your final amplifier to your antenna, assuring that you get maximum power output. You must retune each time you change bands or frequencies.

Tuning up transmits a high pitched tone on the air. It is very annoying to others who may be in conversation on that frequency. Listen before you tune up and make sure that frequency is clear; then tune quickly.

An even better method is to use a *dummy load* (Fig. 6-1). This device takes the place of an antenna but absorbs all the power from your transmitter allowing none of it to get on the air. Tune your rig using one and you make everyone happy. In fact, it will even make your transmitter happy because it is the perfect antenna, an absolute perfect match. You still must tune on the air using an antenna, but pretuning with a dummy load reduces that time.

Interference

As more and more hams get on the air, interference will increase. But with proper operating techniques, like using a dummy load, interference between hams can be minimized.

Very often, because of propagation conditions you are not able to hear

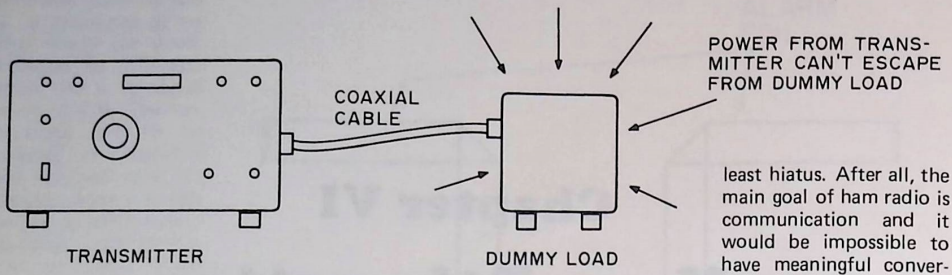


Fig. 6-1. Dummy loads keep your signal off the air.

both sides of a conversation. If propagation is in favor of long distances, stations relatively close to you will skip right over your station and you won't hear them. So unless the other fellow who is far away is talking, you would never know that a conversation is taking place. If you started to transmit, you would ruin a contact. A simple procedure however prevents this (Fig. 6-2).

Before using a frequency, listen for a minute, then ask: "Is this frequency in use?" If you hear someone say yes, move to another place on the band. Sometimes the operator may invite you into the conversation; other times he may just thank you for asking.

For Morse code another method is used: sending a question mark. If the frequency is occupied, the reply will be the letter "C." "C" is short for "correct" or in this case "yes." ("N" is short for no.)

If the frequency is not in use, call "CQ" – a call to any ham who may be listening and wants to talk to you. On phone (voice) say:

"CQ, CQ, CQ – this is K2APZ calling CQ. Kilo TWO Alpha Papa Zulu calling CQ 20 meters." (If you are using 20 meters.) Repeat only a few times. This gives someone a chance to tune you in and maybe turn his beam in your direction. If someone is listening it won't take many CQ's to get him to answer.

Notice that phonetics are used to make the letters clear and easy to understand. The phonetic alphabet is internationally accepted but many hams like to use their own. Using phonetics of cities and countries is sometimes easier to comprehend. For instance, using "America" for the letter "A" instead of "Alpha" is far more familiar, especially to the foreign ham. Phonetics of common phrases work well too. A ham whose suffix is "LRL" says: "Left-Right-Left." Then there is W2ZOW who chants "*Two Z*ippy *O*ld *W*arriors" into the mike.

A – ALPHA	N – NOVEMBER
B – BRAVO	O – OSCAR
C – CHARLIE	P – PAPA
D – DELTA	Q – QUEBEC
E – ECHO	R – ROMEO
F – FOXTROT	S – SIERRA
G – GOLF	T – TANGO
H – HOTEL	U – UNIFORM
I – INDIA	V – VICTOR
J – JULIETT	W – WHISKEY
K – KILO	X – X-RAY
L – LIMA	Y – YANKEE
M – MIKE	Z – ZULU

Table 6-1. International phonetic list.

Breaking In

Hams usually do not break into another conversation unless there is good reason to. But when they do, the procedure is to say "break" between the transmissions. Then the breaker waits to be acknowledged. If he isn't, it means he is not heard. In that case it does not make sense to keep yelling "break."

But more often than not, if you want to join a conversation or if you just want to talk to one of the operators, it is best to wait until their conversation is ended; or at least hiatus. After all, the main goal of ham radio is communication and it would be impossible to have meaningful conversations if stations broke in all the time.

In an emergency things are different. Instead of saying "break," say "BREAK EMERGENCY." That gets attention fast. If it is very urgent, break while one operator is talking. If you can be heard over him you will be taken to a clear frequency to conduct your emergency business. Be sure to go back and tell the other fellow what happened. He will be wondering what became of his contact.

Using Repeaters

On repeaters, the way to break in is the same – between transmissions. But the way to call "CQ" is different.

Repeaters are preset to operate on two chosen frequencies: input and output. There is no dial twisting and no tuning; all users are listening on the same frequency.

This makes calling "CQ" easy because all you do is transmit and say that you are listening to the repeater. You might say: "This is K1OJQ monitoring 34-94." (34-94 are the input and output frequencies of the repeater.) If someone is there, he will hear you the first time – no need to repeat it.

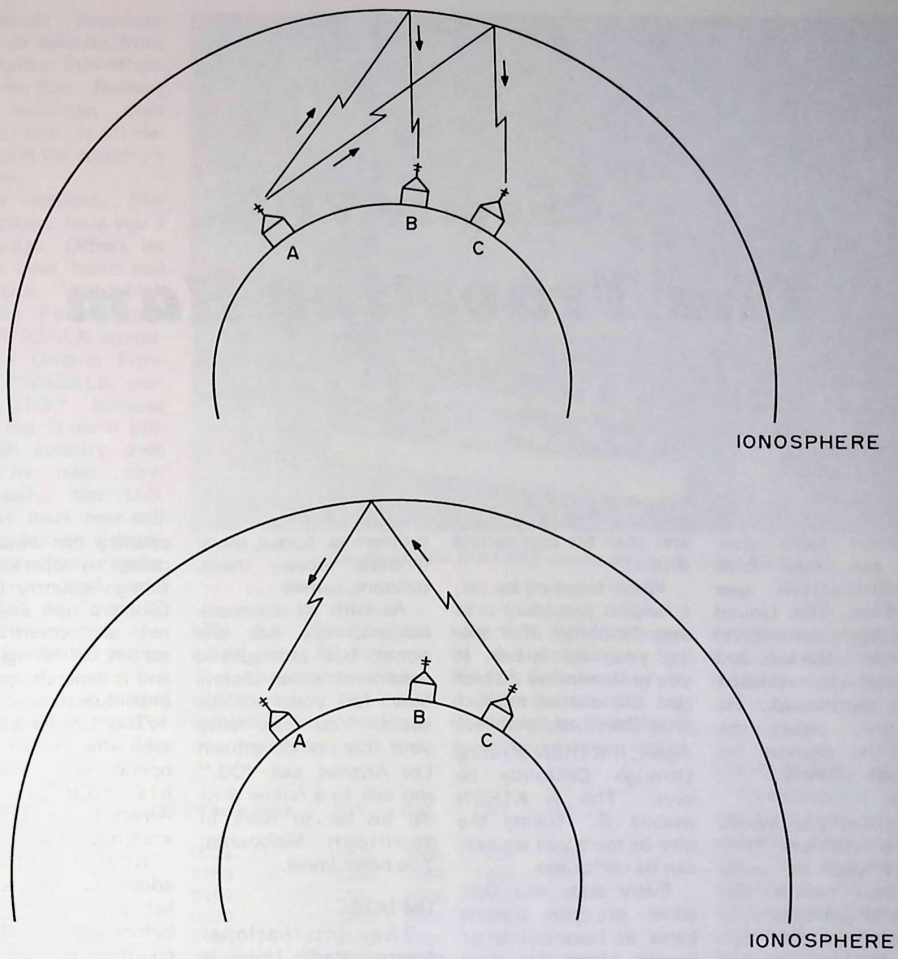


Fig. 6-2. When A transmits, both B and C can hear him. But when C transmits, only A can hear him because the "skip angle" is too small for the signals to reach B.

Chapter VII

The Traveling Ham

Amateur radio operators can take their communications gear everywhere. The United States ham can travel anywhere in the U.S. and possessions without special permission. He must only notify the FCC if he changes his permanent address.

The country is divided into 10 districts (Fig. 7-1). If you are away from your regular district, it is customary to tack on a "portable" followed by the district number. For instance, if you call "CQ" and give your callsign as K1HZN, people assume that you are located in the "1" district which includes Connecticut, New Hampshire, Rhode Island, Maine, Massachusetts and Vermont. But you might very well be in California. So most hams away from home say: "K1HZN portable 6" – if they are in the 6th district which is California. The same goes for code. After your callsign, send a slant bar (/) and then the appropriate district.

When traveling by car, a helpful procedure is to say: "mobile" after giving your call letters. If you're in another district give the district number after the word "mobile." Again, if K1HZN is riding through California he says: "This is K1HZN mobile 6." Giving the city or town you are near can be useful too.

Every state and Canadian province permits hams to have call letter license plates for their cars and trucks. The purpose is to let the public know who has equipment in his car available for emergencies. It also makes it easier for hams who are participating in emergency activities to drive through restricted areas. The amateur is never the "police officer" but he is the *communicator* for the authorities when they ask for his help.

Not only do hams operate from their cars, but from planes, boats, submarines, horses, snowmobiles, subway trains, balloons, camels . . .

As with all communications, it's not the power but atmospheric conditions which dictate how far you will be heard. You can drive your car in downtown Los Angeles, call "CQ," and talk to a fellow driving his car to work in downtown Melbourne. You never know.

The IARU

The International Amateur Radio Union is part of the International Telecommunications Union, and is the amateur's voice in world radio affairs. The ITU, located in Geneva, Switzerland, runs amateur radio station 4U1ITU, and any ham from any country can operate it. And this brings us to reciprocal licensing.

Just as there are international reciprocal drivers licenses, there are reciprocal amateur radio licenses. A ham from one country can obtain a license to operate in a foreign country without taking a new exam. But not all countries are parties to this agreement and it depends upon each individual nation.

The United States allows any foreign ham to operate in this country if his country allows American hams to operate from there.

New countries are added to the reciprocal list all the time; check before you go. But if a country is *not* listed, don't give up. It may just mean that nobody ever asked to operate from there on a reciprocal basis before. The subject never came up and no formal agreements were reached.

Countries have different license structures and they allow you a comparable class of license when you visit. For instance, most nations do not have Novice licenses and so they don't recognize ours. Others have Novice-like classes and

will permit American Novices to operate from their country. Still others give American Novices greater privileges than they get here. It all depends upon the country's radio laws.

Some nations, like Great Britain, issue you a new callsign. Others let you use your home call with the "portable" tacked on. For example, station WA2ALK operating from Ontario Province is "WA2ALK portable VE3," because VE3 is the Ontario prefix. Each country does things its own way. (Incidentally, the U.S. does not issue new call letters to foreign visitors. They use their regular callsigns and add "portable" or "mobile" and the appropriate district: W1, W2, W3 and so on.)

Operation from a boat requires another type of suffix designation. The ITU has divided the world into 40 regions. The operator decides which region he is in (provided he is not in a country's sea limit) and adds that region number to his callsign. So, WA7BKR operating in the North Atlantic, region 5, says: "WA7BKR maritime mobile region 5." The same rule applies to aircraft too. The region is then defined by the airspace you are flying through.

Chuck Martin WA1KPS works all bands from his truck.

UTC	UTC 24 hour clock	EST	CST	MST	PST
12 mid	0000	1900	1800	1700	1600
1 AM	0100	2000	1900	1800	1700
2 AM	0200	2100	2000	1900	1800
3 AM	0300	2200	2100	2000	1900
4 AM	0400	2300	2200	2100	2000
5 AM	0500	0000	2300	2200	2100
6 AM	0600	0100	0000	2300	2200
7 AM	0700	0200	0100	0000	2300
8 AM	0800	0300	0200	0100	0000
9 AM	0900	0400	0300	0200	0100
10 AM	1000	0500	0400	0300	0200
11 AM	1100	0600	0500	0400	0300
12 noon	1200	0700	0600	0500	0400
1 PM	1300	0800	0700	0600	0500
2 PM	1400	0900	0800	0700	0600
3 PM	1500	1000	0900	0800	0700
4 PM	1600	1100	1000	0900	0800
5 PM	1700	1200	1100	1000	0900
6 PM	1800	1300	1200	1100	1000
7 PM	1900	1400	1300	1200	1100
8 PM	2000	1500	1400	1300	1200
9 PM	2100	1600	1500	1400	1300
10 PM	2200	1700	1600	1500	1400
11 PM	2300	1800	1700	1600	1500

Table 7-1. UTC time conversion chart.

Universal Time

Globetrotting as we do, it is nice to have a universal time we can all use. The accepted time standard is *Universal Coordinated Time,* abbreviated *UTC.* (No mistake; it's translated from French and comes out UTC.) Greenwich Mean Time or GMT was used — in fact, nothing has really changed except the name. UTC is still the time at Greenwich Observatory, Greenwich England, the time standard of the world (Table 7-1).

Mobile

The newer, smaller transceivers lend themselves readily to mobile operation. Their size is a great advantage and they

can fit easily under the dashboard of a car without interfering with the driver.

Hams can purchase 80 through 10 meter transceivers for car use and can operate all bands while driving. The only problem is the antenna, which must obviously be a whip type, and must also resonate at the desired band frequency. The whip antenna is like the vertical antenna but because of its shorter length, it must make use of "traps" or "resonators" to give the transceiver the impression that it is transmitting into a longer antenna. Each frequency band uses a different resonator and most mobile operators carry those for the bands they wish to use. If you want to operate 80 meters, put on the 80 meter resonator. If you want to work 40, you use the 40 meter resonator. The antenna whip remains the same for all bands.

One antenna, rather new to the market, makes changing traps by hand unnecessary. The traps for all bands are built into one housing which is part of the antenna itself. To change bands, the operator simply changes traps from inside the car by flipping a switch. This allows him to operate on different bands without stopping the car.

Since car batteries are 12 volts dc, the mobile transceiver must be able to use this 12 volt supply too. Many transceivers are designed to operate directly from a 12 volt supply; others, however, require a special dc to ac power supply converter. If you think you would like to operate mobile, your best buy is a transceiver which can be operated from house current and dc.

During the "Tall Ships" regatta celebrating America's bicentennial birthday WA2OLP used his Walkie-Talkie to direct marine traffic.

Al Coya WB4SNC talking with Rome, Italy, East Germany and Spain while riding his bike.

Remember that power for mobile operation should be taken from the alternator supply and not directly from the battery. If you take power directly from the battery you could use up the cells rather quickly. Car batteries were not designed for heavy transmitter use. Also keep in mind that while the transceiver is in the receive mode (you are just listening), very little current is being used. It's only when you transmit that you use lots of power. Keep your transmissions short. 100 Watts of power is quite a bit for a car battery to handle.

When operating from your car, you will not be able to use the regular type of desk model microphone. You must use a mobile microphone. The hand-sized mobile push-button microphone makes it easy to operate while you drive.

2 Meter Mobile Operation

As we said in Chapter 3, many hams use 2

meter FM repeaters for mobile operation. This band is very popular with the mobile crowd for many reasons. First, the 2 meter FM transceiver does not have to be high powered. It can be as little as 1 Watt because you just have to be able to "trip" the repeater, made smaller than high powered rigs.

Another 2 meter advantage is the short antenna. 2 meter antennas are customarily quarter wave whips – only 19 inches long. Because of its short length it can be made of smaller gauge metal. It possesses little many noises are eliminated. In fact, many hams refuse to operate anything other than FM from their car; they just can't tolerate all the noise they hear on their Single Side Band rigs. (SSB is a form of AM.)

2 meters was the first band to accommodate only used by hams in cars or those with handie-talkies. While most repeater users are in these categories, there is no restriction on repeater use by any station. However, most base stations find it unnecessary to use repeaters because they already have the power

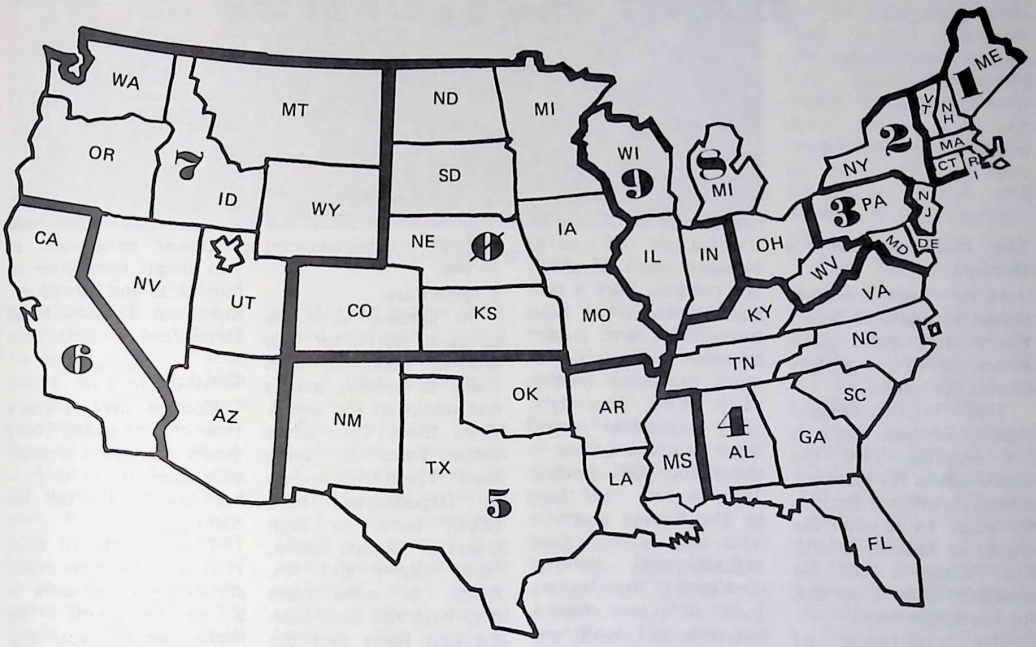


Fig. 7-1. District map – Hawaii and Pacific islands are in district 6; Alaska, district 7; Caribbean islands are part of district 4.

that is, activate the repeater station for others to hear you. Since most repeaters are in very high locations, have good antennas, and use very sensitive receivers, even the lowest powered units can use them. The advantage of using low power transceiver for mobile work is that it presents little drain on the battery. Also, low powered units can be wind resistance compared to heavier lower band antennas.

But still another advantage of 2 meter FM operation is the low noise. Most noises such as wheel static, atmospheric noise, and engine whine are amplitude modulated in nature. For the most part, only AM receivers can pick up those sounds. By using an FM receiver, repeaters so it is heavily inhabited, but repeaters are springing up on higher bands such as 1¼ meters (220 MHz band) and .7 meters (420 MHz band). They all possess the same advantages that 2 meter repeaters enjoy. In addition, antenna lengths for these bands are even shorter, making mobile mounting easy.

Don't get the impression that repeaters are they need for communication and don't need the repeater's help.

Needless to say, autopatch facilities, in which the operator uses his car transceiver or handie-talkie to patch into the phone lines, are restricted to those units in the "field." It would be silly to use the autopatch when you are operating from your home station.

Chapter VIII

Ham Activities

The Hobbies Within a Hobby

Ham radio encompasses so many different facets that many operators have a hobby within the hobby.

The most popular "sport" in ham radio is DX hunting. DX, the abbreviation for distance, means working stations far away from you. The word, of course, is relative. What is DX for stateside hams is not DX for European hams.

The challenge of DXing is trying to work rare and obscure stations. Rare because they may be located in a newly formed country and perhaps no one has worked them before. Hams collect exotic prefixes as coin collectors add new coins.

To verify contacts, hams exchange QSL cards. These cards are sent directly by mail or through QSL bureaus.

QSL bureaus, operated by radio clubs, exist in every country. They were formed to facilitate the exchange of cards between hams of different nations. Here is how they work: If I have many QSL cards I want to send to French amateurs, instead of mailing each one separately, (very expensive) I send them in one envelope to the French QSL bureau. They in turn mail them to the French amateurs who have already filed self-addressed, stamped envelopes at their bureau. I not only save money, but time, as I don't have to look up the French ham's addresses, only their call letters.

Some foreign bureaus also handle *outgoing* QSLs. The bureaus collect outgoing cards from their members and send them in bulk to other bureaus all over the world.

In the United States private hams have set up outgoing QSL bureaus. For about 5¢ or 6¢ a card, they forward QSLs to foreign bureaus. Again, by sending in bulk, they save money and pass the savings along to you.

DXpeditions

In keeping with the constant search for new and rare countries, hams travel to obscure islands and nooks of the world. Once there, they allow other hams to work them. These trips known as "Dxpeditions," have taken hams to such places as Navassa Island, Swan Island and Mt. Athos. In some cases they have not only been the first hams, but the *first people* to visit these places.

A less exotic form of a DXpedition is Field Day. Once a year, hams take their rigs to the boondocks and relying only on self-generated power, try to work as many stations in a two-day period as possible. Plug-in-the-wall power is prohibited and you get extra points for using alternative energy such as wind, solar and human power. The purpose of Field Day is to test your operating skills under adverse and no-power conditions as you might encounter in hurricanes and tornadoes. But most of all — Field Day is fun!

Contests

Contest time is crazy time in ham radio. Every group is allowed a diversion where it can let go — contests fill the bill for hams.

The purpose of contests is to see how many stations you can work in a specified time. The more stations you log, the higher your score. And sometimes you get multipliers for each *new* country or state that you talk to. One contest, the DX Contest, is a two day scramble to work as many foreign hams as you can. You receive no points for talking to U S hams and you cannot work the same person twice. It's not only a test of skill but endurance, although every station must stay off the air for several hours to allow sleeping time. You can work the test alone or

QSL cards from around the world.

with others. Each type of operation is a different category. Other categories are low and high power; this way very powerful stations don't have an unfair advantage.

Aside from the famous DX contest, held twice a year, there are also contests to see how many hams you can talk to using VHF frequencies, using one band, using one mode or other special criteria. It's all great fun — especially if you win.

Certificate Hunting

Just as the DXer tries to work new and rare countries, the certificate hunter sets his sights on one region, area or special group of hams to work. For instance, he might try to work at least one ham in each state. If he does, he can receive the Worked All States (WAS) award sponsored by the ARRL. Some hams try for WAS on only one band or one mode; then get the WAS award endorsed for that specialty. It's a challenge and it takes great operating skill.

One of the most sought after awards is the DX Century award. To get that award you must work 100 countries. That's not as hard as it seems because 'ham radio countries' don't necessarily follow normal borders. For example, Puerto Rico is considered a separate country; so is Alaska. And many small Pacific Islands list as countries on the 'official countries manifest.' Both these awards, WAS and DX Century, are not restricted to US amateurs. Any ham can get them.

Very often, clubs sponsor awards. A radio club in New York might give a certificate to any ham who worked 10 members in its club during a specified time period, a weekend perhaps. The club then prints and sends out certificates to those who worked them.

Phone Patches

A ham in New York City talks to a ham in Seattle. The New Yorker's sister lives in Seattle and he asks if the west coast operator has a phone patch so he can speak to her. He does, and connects the phone patch to his transceiver. He then calls the fellow's sister. She talks into her phone, through his transceiver, over the air, where her brother receives her on his radio. Since the cost of phone calls has gone down in recent years, phone patches are usually not planned but happen on the spur of the moment as the New York City — Seattle connection did (Fig. 8-1).

Phone patches are important for international communications where it is often easier and sometimes more practical to use ham radio. In order to run phone patches however, two countries must have ratified "third party" agreements. This means that they both allow messages (including phone patches) between those who are *not* amateurs. In most cases, whether the country permits third party messages or not, rides on who owns the telephones and communications media. If the government owns them, they are occasionally embarrassed by the quality of ham communications and afraid of the competition.

This is true even though hams can *not* use their stations for pecuniary interests — or the taking of money, goods, or services for phone patches and messages.

The United States permits its hams to have third party agreements with any other country. Usually, it is the other country which disallows its hams from doing so and we must abide by the country's decision.

The bulk of third party traffic, is to military personnel overseas and to those in remote areas without access to normal communications. Scientists in Antarctica rely solely on ham radio to contact friends and relatives in the States. Military stations can't be used for personal messages unless they are MARS. (More on MARS later.)

Many scientific expeditions use ham radio. The Kon Tiki had a ham aboard and so did the Mauritania Solar Expedi-

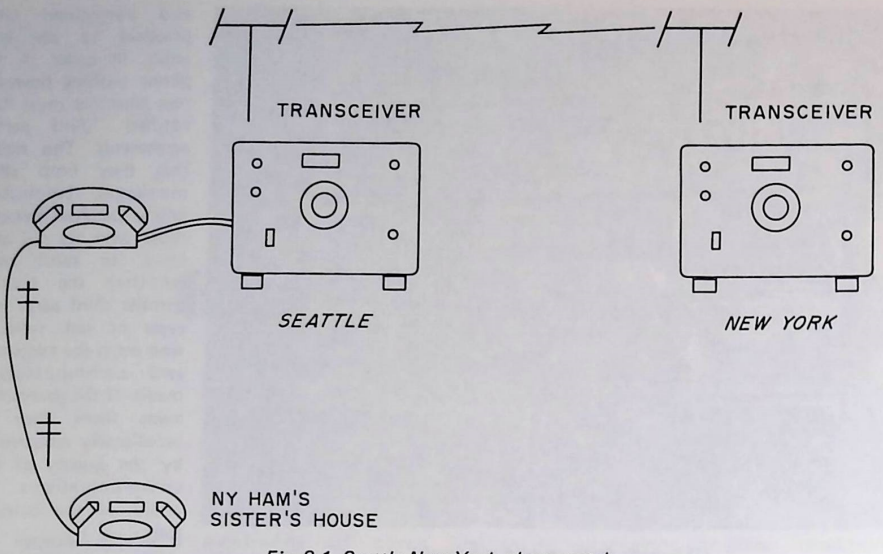


Fig. 8-1. Seattle-New York phone patch.

tion to Africa. Radio operators aboard research vessels provide the crew with personal phone patches to their homes without charge at all times.

Traffic Nets

Traffic nets handle messages via ham radio. These regional networks meet every day and route messages around the country until they reach their destinations. A ham then calls up the recipient, or if he is close enough, delivers the message personally. Either way, the message is moved by ham radio quickly and without cost. Traffic handling is not only fun but keeps skills sharp for emergencies when you may be called upon to handle an extremely important message.

Other nets not concerned with messages are either regional, national or international and focus on a common interest to the operators who 'check in.' There are UFO nets, to discuss and search for UFO phenomena, weather nets, astronomy nets, chess nets, alternative energy nets, nets for those in one type of occupation and much more. There is a net for anything you want. If none exists in your field, start one. You have the opportunity to talk with others about similar interests despite great distances.

Remote Control

Radio control models are permitted to operate on frequencies of 72 MHz. These special channels are not ham frequencies but are used only by remote controllers. If you go to a busy airfield, you will see many fliers waiting around but not flying their planes. They are waiting for a clear channel. But here comes the ham radio operator who is permitted to use the frequencies above 6 meters for remote control and he flies right away. Another great advantage of having a ham radio license: the frequencies above 6 meters can be used for remote control. There are lots of radio control modelers who are amateurs and use the ham bands to control their planes.

Public Service

Aside from message handling, hams engage in emergency networks such as MARS and AREC. MARS, the Military

West Gulf Hurricane Net
Mutual UFO Net
Trans-Canada Net
New England Barnyard Net
EastCars (East Coast Amateur Radio Service)
Eyebank Net
Georgia SSB Net
Argus Net (Astronomy)
RV Net (recreational vehicles)
Midwest CW Net
Old Goats Net
International SideBand Net
Marine Net
New Directions Net (alternate energy and lifestyles)
Intercontinental Net
New Hampshire Emergency Net
Chess Net
Great Lakes after school net
Midstate Weather Net
Coast Guard Net
New York RTTY Net

Table 8-1. A few networks.

This facsimile picture was sent via satellite and received by Wally Lamb WØPHD in Minnesota.

Affiliated Radio Service, combines the military and amateur communities. Hams are given special callsigns by the Secretary of the Service (Navy, Army, Air Force) and the two services work together in disaster and emergency operations. Members meet on the air once a week to discuss procedures and handle traffic. Special frequencies outside regular ham bands are used. The advantage of MARS to the operator is that he can utilize his station in a constructive way. The advantage to the public is that it gets a highly trained, local group of hams with access to military outlets who can act on a moment's notice if they are needed.

AREC is the Amateur Radio Emergency Corps and much like MARS, concerns itself with emergency communications. AREC holds drills and simulations for its members. Public safety organizations such as the police and the Red Cross know that they can depend upon AREC for reliable communications in crises. Many AREC stations equipped with emergency power are often better prepared than the police and fire department.

OSCAR Satellites

Hams are always in the forefront of progress, so naturally we have our own satellite — yes, our very own.

The OSCAR series was an experiment to see if civilians could receive satellite messages using only ordinary receivers. It was a great success as hams from all nations could hear "HI" transmitted in Morse code. (HI in ham lingo means laughter.) Many OSCARs came, all built without government money or government assistance. NASA did, however, give us a free ride into orbit. Most rockets carry payloads of two or three satellites anyway — we hitchhiked.

OSCAR 7 is by far the most sophisticated of the series. It has two repeaters, each on a different band and each operating on alternate days. Orbital data is published in ham magazines and the calculations for tracking it are simple arithmetic computations. Although code is the most common OSCAR mode, contacts using teletype, single sideband, and slow scan TV are performed every orbit pass.

Truly an international project, hams from all over the world had a part in building OSCAR. A German group built one section, an Australian group built another and so on. The project, coordinated by AMSAT (AMateur SATellite Inc.) based in Washington, is an organization formed by hams to organize and disseminate satellite information. Anyone can join whether he uses the satellite or not.

If all this has you up in the clouds, come down. OSCAR is very easy to use. The total cost of my "special" equipment is $25. I use my regular ham receiver for the down-link (incoming signals) and a surplus transmitter ($20) for the up-link (my transmissions). The other $5 went for a special antenna to make access easier.

I guess you are wondering about the name OSCAR — here goes — Orbiting Satellite Carrying Amateur Radio.

Moonbounce

The next activity is rather exotic, I must admit. It requires lots of time and maybe a little more money than other ham activities. Still, it's not beyond the range of most hams.

It is moonbounce. A small group of about 50 hams bounce signals off the moon and back to earth where other hams receive them. Conversations can be carried by using the moon as a reflector of radio waves. Referred to as Earth-Moon-Earth, (EME) it is an international project.

It calls for great patience because so few hams do it. And the moon is not always seen by the few who do engage in EME. Most contacts are by predetermined schedules. The antenna systems for EME rival the most complex commercial ones and usually have elements (the parallel tubes that are the reflectors and directors of beams) numbering over 100. Many hams asked for and received special permission from the FCC to increase power beyond the legal 1000 Watts. The moon is over ¼ million miles and power losses are astronomical.

It was exciting for me to see a moonbounce in

progress at the station of Barry Forrest, WA2BIT. He looked at his computer printout of the elevation and azimuth of the moon and set his antenna control to move the monstrous 116 element antenna so it would follow the moon through the sky.

He turned the dials of his transmitter and told me to send some code. I did. The signals came back 2½ seconds later. That's the time it took the radio waves, traveling at the speed of light, to bounce off the moon and return to earth. I was totally amazed as Barry slowly said in a nonchalant manner; "Sorry there was no one there now. Come back later and try again."

Just hearing my moon echo was enough for me.

Hobby Computers and the Ham

Hams and computers interface beautifully — that is, they get along. Hams were one of the first groups to use and enjoy the new breed of minicomputer known as the hobby computer. These computers are small and can be bought for under $1000 complete with screen for displaying the output, keyboard for input information, memory for storing data and other peripheral devices. Just like Hi-Fi in the late 50's, home minicomputers will be the coming plaything for tinkerers and experimenters. Using ready made programs from the manufacturer, you don't have to know everything about computers to use them. You can store you friends' phone numbers, addresses, birthdays or any other information you want. Then, at a press of a button or two, retrieve the data quickly. Leaving baseball behind, computer games will soon be the national pastime. Already you can buy space attack games, submarine games and football games to play on your computer.

Many minicomputers are offered as kits lowering the price a great deal. Others, of course, come ready to use.

Hams use computers around the shack to "remember" contacts, set schedules and calculate propagation conditions. Some even have computers run their stations.

One ham has his minicomputer send an automatic CQ. Then the computer logs the contact, signal report and other data the operator wishes to save. He even has his computer send an automatic identification every ten minutes as the rules require.

Computers were linked using an OSCAR satellite by hams who sent data between their computers via the space route.

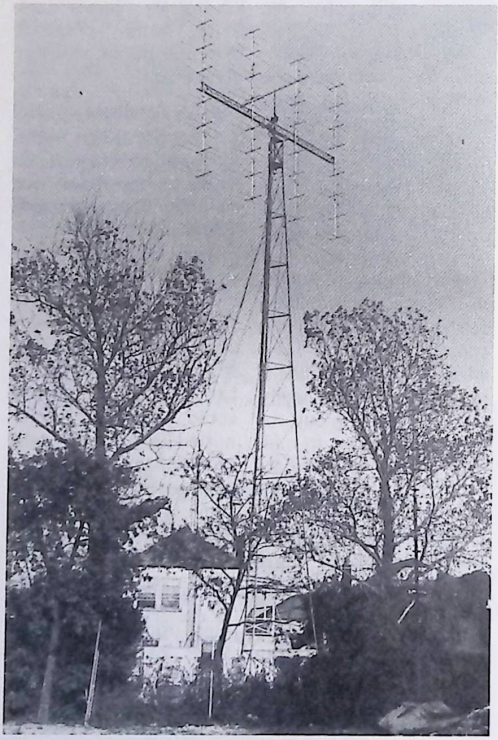
Using minicomputers in the ham station is still very new, but we can expect more of it as we learn about these machines.

Hum . . . do you think the computer can take the license test for me?

VHF and UHF

Because operation at very high and ultra high frequencies is so unique, many hams make it their special interest. The higher you go in frequency, the more radio waves approach the characteristics of light. The waves tend to bounce off buildings and other solid surfaces and communications are normally line of sight. Sometimes, however, interesting atmospheric conditions change all the rules.

For instance, it has been shown that high frequency radio waves will bounce off such ethereal items as comets' tails, auroras and rare temperature inversions. Hams look forward to these events as opportunities to bounce their signals to other hams. Needless to say, the practice takes patience and skill. The results are not always satisfactory either. You might stay up all night and find that your calculations are slightly askew or for one reason or other, it just won't work. Then why do it? Why frustrate yourself? The answer is simple — challenge. How many folks can say that they bounced radio waves off an aurora borealis, then talked to another ham over 200 miles away? Not many. To be the first person, amateur radio operator or other, to accomplish these things is something to be proud of. By plugging away at some of these tasks, hams have done things with high frequency waves that even the "experts" have not.



Moonbounce antenna used by Barry Forrest WA2BIT.

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